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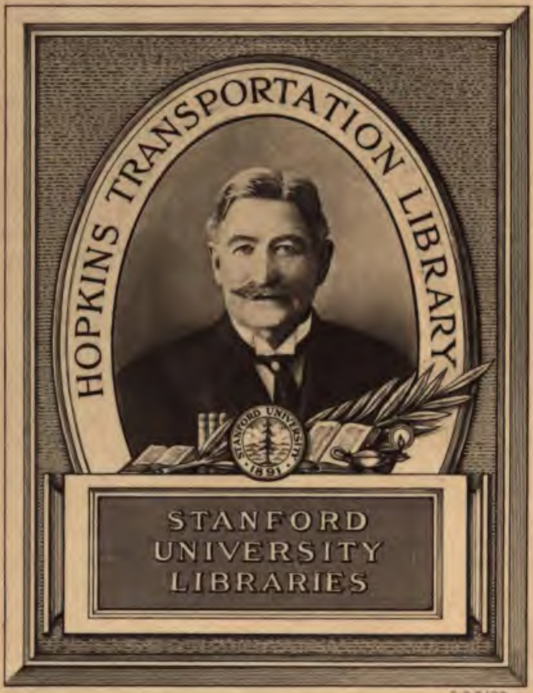
PNEUMATIC TRANSMISSION

YALLANCE

1827.

661



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1836

A LETTER

TO

M. RICARDO, ESQ.

IN REPLY TO HIS LETTER

TO

DR. YATES,

ON

THE PROPOSED METHOD OF PNEUMATIC TRANSMISSION,

OR

CONVEYANCE BY ATMOSPHERIC PRESSURE.

BY

JOHN VALLANCE.

"I'll talk a word with this same learned Theban."

BRIGHTON:
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BALDWIN AND CO.'S, 47, PATERNOSTER-ROW, LONDON.

1827.

1827

"And what of this new book, the whole world makes such a rout about? Oh! 'tis out of all plumb, my Lord;—quite an irregular thing;—not one of the angles at the four corners was a right angle;—I had my rule and compasses, my Lord, in my pocket.—Excellent critic!

"And for the epic poem your Lordship bid me look at;—upon taking the length, breadth, height, and depth of it, and trying them at home upon an exact scale of Bossu's;—'tis out, my Lord, in every one of its dimensions.—Admirable connoisseur!

"Grant me patience, just heaven! of all the cants which are canted in this canting world;—though the cant of hypocrites may be the worst,—the cant of criticism is the most tormenting."

A LETTER

TO

M. RICARDO, ESQ.

SIR,

AMONG the duties we owe to society is that of endeavouring to counteract the effects of representations, which are likely to lead to the investment of capital in undertakings that might prove ruinous to those whose property becomes embarked in them; and there are few more entitled to our approbation than he who stands forward to expose the absurdity of schemes, which, though plausible, and to those incapable of judging correctly, apparently sound in principles, are yet delusive and without solid foundation.

In replying, therefore, to the objections of one who has stepped publicly forward to oppose a proposition, which, at first sight, certainly appears liable to be classed among projects of this kind, it becomes the respondent to give his opponent credit for motives of the most praiseworthy nature, provided that opponent has, in the first place, taken all possible opportunities of enabling himself to judge correctly of the proposition on which he pronounces his opinion; and provided, also, that his judgment be fair and just. But should it be evident, to a degree which renders it impossible to close our eyes against and shut out the perception, that instead of EXAMINING and drawing his conclusions from facts, such opponent has been unjust enough, not merely to suffer pre-conceived notions and prejudices grossly to bias his opinion, but also to *misrepresent*, *mis-state*, *mis-quote*, and *falsify*, common justice demands that the party he condemns should be allowed to enter his protest against a judgment, that cannot be less ungenerous than it is unjust.

In support of a proposition I advanced, as capable of an application, which, in my opinion, would be publicly beneficial in an important degree, I had a treatise of about 100 pages printed some time ago; and as the application of the principle which this pamphlet treated on, appeared to warrant it, the three words "On Insular Defence" were impressed on its title page. But as I intended it for my friends, and not for the public, I had the words "FOR PRIVATE CIRCULATION ONLY," displayed on the cover.

In conformity with this precaution it was never published, advertised, nor sold; and has been seen only by those whose curiosity (expressed or implied) induced me to give it them. Understanding from a friend, that you wished to have more correct information as to my opinions on the subject it treated on, than common report gave, I put a copy of it into his hands for your perusal; which copy (or another) it appears you have in your possession.

In this treatise, I recommend the adoption of a method of transmission, by which it appears to me, that TIME may be saved in a degree that will be most important; and EXPENSE in a proportion that will be far from unimportant.

Under the hope of gaining attention to the proposition, I attempt to shew that in *addition* to advantages of a commercial nature, it will confer upon us the paramount benefit of impregnability, and render nugatory any attempt to subject us to the horrors of war, in the way we should have experienced, had [illegible] succeeded in the meditated attempt to describe it. And, after giving a general view of the subject, so as to render it comprehensible to my friends, and endeavouring to make them see that the proposition was not impossible or opposed to practical application, I concluded by urging its adoption on a short line: that those points which only practice can resolve might be ascertained, for the reason, that "on being once proved and found to answer for a few miles, the principle would become invaluable to us." With a view to this, "and owing to an opportunity there given to prove it for a few miles, prior to incurring any very large outlay," I recommend the formation of a Company to put it in practice between Brighton and Shoreham; stating that "should any person feel desirous of taking shares, it will be best *first* to witness and experience the operation of the principle which is in practice at Brighton:" and as Shoreham is named *above a dozen times*, I considered it impossible that my object could be mistaken.

In consequence of the conviction which the theory and practice here adverted to produced, this recommendation was recently acted upon so far, as for a numerous and most highly respectable public meeting of the inhabitants of Brighton to resolve :—

"That in the opinion of this meeting the method of transmission proposed by Mr. Vallance, would be productive of the most important advantages to the town of Brighton, and that the application of it, *either as it relates to the transit of goods from Shoreham Harbour to Brighton*, or to the conveyance of passengers between Brighton and the metropolis, is entitled to the most cordial support of the town."

On this occasion you stated you felt it your duty to stand forward, and *speak* against the proposition, and you have now stated you felt it incumbent on you to oppose it in print, as in your letter to Doctor Yates.

Against neither the one nor the other of these kinds of opposition could I, nor should I complain, provided they had been confined to their legitimate object—a fair examination of the practicability of my proposition as before the public—that is, in its applicability to *the conveyance of goods between Brighton and Shoreham*. But when I find myself attacked, not with arguments and inferences drawn from facts, but, first with mere assertions, and then with ridicule, sarcasm, and invective; accused of extolling myself and my invention to the skies; of exceeding all limits of probability, and giving as probable what was impossible; of the very quackery of science; and not merely of ignorance myself, but of the dishonesty of attempting to take advantage of the ignorance of others: when I find these charges alleged against me, and that a treatise written and most conspicuously marked, "For *private circulation only*," and which also came *privately* into your hands, is not merely rendered the basis of an attack which ought to be confined solely to the proposition before the public, but also mis-quoted and falsified, while my real object and public proposition is studiously avoided: when, Sir, I am made to feel these things, I should be apathy itself not to feel also, that it is equally due to myself to render evident the injustice, as is it is due to the public proposition I have actually made, to render evident the incompetence of your criticism.

I have stated publicly in your hearing; and I have stated in the pamphlet you refer to—so stated it indeed as for "Brighton and Shoreham" to stand in juxta-position *nearly twenty times*—that my object was to get the principle put in operation between Brighton and Shoreham Harbour; a distance which *cannot exceed six miles* and may be *under* five. The report of the Committee *refers* to this application; as do the resolutions of the Public

Meeting. It cannot therefore have been *unknown* to you, that the utmost extent of the *present* application of the principle I propose, *is only six miles;* nor was it less known to you that its *first* object is the conveyance of goods from *Shoreham Harbour to Brighton;* yet "with these facts staring you in the face," (your own words, page 68) do you state at page 9, not that I have, *privately*, and as to a friend, expressed my conviction that it will *eventually* become generally adopted, and applied to purposes of military transmission, but that "as one of his great objects is to make it a means of speedily conveying troops to any part of the coast where they may be wanted, THE TUNNELS ARE TO BE IN ALL DIRECTIONS, and 200 or 300 miles long, if required: through these the carriages are to move at any rate in which it would be safe for wheels to revolve from 100 miles an hour, or even more, if necessary;" and in conformity with this *mis*representation of my object, do you, throughout your Letter, keep studiously out of sight my real proposition,—namely, that of getting the principle tried for a *few miles*, "and ascertaining those particulars which only *actual practice* will satisfy us about,"[1] while you at the same time thrust prominently forward and argue solely upon, what I have certainly largely adverted to as an *ultimate* (but only as an ultimate) effect, as if I were attempting to inveigle the public into a trial of the proposition on the random scale of—not merely hundreds, but thousands of miles; and at an expenditure of seventy-five millions; and indeed you even go so far as to say, "it would be really amusing to see how a proposition would be received by the House of Commons, to raise such a sum for this plan of Insular Defence, and how readily the country at large would yield to additional taxes to that amount;" and then at the close of all this, you have the modesty to exclaim, "I have carefully endeavoured to avoid any thing like exaggeration, and I have, on revisal, expunged some parts which I feared might be considered so."

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[1] My Treatise, page 78.

Under misrepresentation of this kind, I cannot sit quietly down; I proceed therefore, 1st, to declare what is my real object; and 2nd, to state circumstances which may indicate the measure of your competence as a critic.

I submit to the public a proposition to the following effect: namely, that it will be remunerative as an investment—tend to reduce the price of fuel to the lower classes in Brighton,—and prove nationally beneficial, in the way that the Duke of Bridgewater's canal proved a national benefit, by opening the eyes of the public to the importance of canals—to put the method of pneumatic conveyance I have proposed and practically demonstrated, into operation between Brighton and Shoreham Harbour, for the purpose of bringing coals and other bulky and ponderous articles of merchandize from the *latter* to the *former* place. From the *presumption* which your Letter to Dr. Yates, by implication, charges me with, do I therefore clear myself, by replying, "the very head and front of my offence hath this extent! no more."

The reasons which induced me to submit this proposition are—1st, because the circumstances stated in the Prospectus, which the desire of guarding against any second misrepresentation of my object causes me to append to this letter, render me satisfied it may be done to the profit both of individuals and the public. 2nd, because the experience we have as to conveying both water and gas through pipes, proves that we certainly may send common air through a tube or tunnel extending from Brighton to Shoreham Harbour.[1] 3rd, because the experience we have as to working iron, brick, and wood, renders it *certain* that we may construct a cylinder, (pipe, tube, or tunnel—call it what you please) of that length, large enough for persons and goods to be conveyed through; and effective as to the purpose contemplated, of either of these materials; and I here pledge myself to bring forward parties willing to contract for its execution and guarantee that it shall be tight and efficient for the purpose, whenever necessary. 4th, because the effect of the practical illustration of the principle which I have in operation, proves that we can make the atmosphere move a carriage capable of conveying both persons and goods, by *actually doing it;* as many persons have witnessed and experienced. 5th, because this illustration of the principle is practical, excepting that instead of being so *long* as would be necessary to serve as a mean of conveyance between Brighton and Shoreham Harbour, it is only of such a length as my humble means admitted of my extending it to—i. e. 150 feet. In size, however, it is fully practical, being nearly eight feet in diameter; and the air pumps are capable of exhausting all the air out of a tube of that size, extending from Brighton to Shoreham Harbour, *in half an hour*. 6th, because common sense informs us, that if it be possible to put the principle into operation, on a scale which is similar to what I propose as to Brighton and Shoreham, excepting that it is not so long, it must be equally possible to extend it that distance as it is to lay down pipes, and send water or gas through them so far. And lastly, because it is impossible that the money expended in doing this, can ever be lost: as even were the plan of transmission I propose by atmospheric pressure utterly to fail, still would the tunnel serve for, and be efficient as a railway, on which either horses or loco-motive engines would draw more than the same power could draw on any other railway.

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[1] The main pipe which conveys gas from the works at Hove to the eastern extremity of Brighton, is above three and a-half miles long. And the length of that of the West Bromwich and Birmingham gas works is stated to be nearly seven miles. The length of the whole of the pipes of the Hove gas works is 16 miles.

These are the reasons which induced me to make the proposition I have publicly submitted. Without even adverting to, much less *refuting* them, you have cast contempt on the proposition by *mis-stating* it: it therefore became necessary for me to rectify the abuse; and having done so, I proceed to enquire in what proportion your *accuracy* as a critic, surpasses your *justice* as a disputant.

Criticism is, I believe, generally understood to mean, an examination into the merits of a question; and I apprehend, universally received as an assumption on the part of the critic, *to be competent to examine*, and pronounce upon the question he criticises. It is expected of him that he shall have fully informed himself upon those particulars which bear on the subject of his scrutiny; and that his decision shall not be impugnable on the grounds of ignorance with respect to points essential to the correct apprehension of the proposition.

With these views of the duties and powers of those who take on themselves the dignity of dispensing judgment from the imperial chair of criticism, it was with no small surprise, I found, on submitting myself to the ordeal, that in his eagerness to *condemn*, the Minos before whom I stood, had neglected to examine; and that I should in consequence have to appeal from his decision, on the grounds of incompetence to decide justly, from *sheer ignorance* as to those points on which depends the very power of comprehension. Yet such is the case; and I accordingly do appeal from the judgment you have pronounced, as ungenerous in reference to the individual, and unjust as relates to the merits of the case. I support this appeal as follows. First, because you do not even comprehend the nature of my proposition. Had you taken the trouble to *examine* before you condemned, you would have learned that your observation, "besides which no human being could exist in air so highly rarified as that would require to be to move at all," has no application whatever to the case; since the persons who might be conveyed by the method I propose, would not be exposed to, nor obliged to respire air at all rarified. My words are—

"Nor are the objections we at first conceive, relative to the effect which pumping air from the cylinder, and producing what only the word *vacuum* (inapplicable as it will by and bye be seen) will enable us to convey the idea of, at all more tenable. The degree to which air would be exhausted from the cylinder, might scarcely ever be sufficient to sink a barometer two inches lower than one exposed to the atmosphere stood at; so that even were we exposed to it, no inconvenience would be felt. But we never shall be exposed to it, any more than those who witness the cruel experiment of putting a mouse under the receiver of an air pump and then exhausting it, are exposed to what the little animal suffers. Between those who see, and the poor creature which *feels* the effect of the apparatus, is the side of the receiver. And between the part of the cylinder in which the exhaustion, or rather the difference of density is, and the passengers in the vehicle, would be the end of the vehicle; so that though close to them would be an atmosphere rarer than (we will suppose) it might prove pleasant to be in, yet would the atmosphere they actually were in, be the same as that of the air at large."[1]

Now, with the theory stated explicitly as is here done, and with my practical illustration, proving the truth of it, your observation, "that no being could *exist* in air so highly rarified, &c. &c.," shews incontrovertibly that you have held up to public contempt and reprobation, what you *do not even comprehend;* and is an irrefutable proof, that in replying "most certainly," when at the Public Meeting you "put it to me as a scientific man, whether your experiencing the operation of the principle would have enabled you to form a better judgment of the plan or not," I was quite right.

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[1] Air of only three-fourths, two-thirds, half, and in Joliffe and Cornillot's ascent, of less than half the usual density (the barometer sinking to 12. 15), has frequently been respired, without any serious consequences.

At page 15, you observe upon the arrangement to which I have adverted for lessening the friction of the air inside the tube by means of *valves*, which the vehicle might open as it passed over them, so as to admit air *behind* it; and after amusing your readers by a display of naiveté on the subject, and assuring them that "necessary as it is that this shutter should be opened, it is ten times more so that it should be shut again;"—you "more than doubt the accomplishment of this part of the work." Parodying the words of our great poet, you may exclaim,

> "He opens! but to shut excels his power."

Now grave as this "more than doubt" is, and much as it implies, still may it be possible to clear it up. In a certain city called London, there is a certain place termed Lincoln's Inn, appertaining to which, and abutting on a certain street called Chancery-lane, (owing to your complaining of its being "usual with me to leave you in the dark on so many interesting points that it is quite lamentable," I will endeavour to be clearly understood on this one point) may be found an office of the Court of Chancery, called the Enrolment Office, in which, about two years ago I lodged a certain instrument, wherein "doth fully and at large appear" how this

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same *unshuttable*[1] valve may be closed; or rather closes itself again; and as this office is well known to, and much frequented by those members of the periodical press, who in their monthly publications give drawings and details of specifications enrolled there, I have no doubt of your being, on application to any of them, enabled to find both the place and the instrument; even if they do not accommodate your "longing ignorance" with letter-press descriptions and copper-plate engravings (waiting only your order for delivery) of this "unknown machinery," the absence of which you so pathetically deplore.

In the same record may also be found some information relative to the mode of telegraphic communication, in juxta-position with which, you place your speaking trumpet of 100 miles long; though I am concerned to be obliged to say, that what may there be found will trivially interfere with the "smooth and even tenor" of the parallel you institute; in so much as it will appear that I have not sufficient boldness of thought to extend the continuity of even the telegraph pipe, further than about the distance between Brighton and Shoreham, instead of the 100 miles to which your more expansive genius so kindly extends it in my name.

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[1] ————————"The apparatus
By which we are *unsuffocated* gratis."—*Byron.*

And as it perhaps may not be so appositely introduced any where else, I will take the opportunity, notwithstanding its being out of place, to observe (adverting to what your postscript says as to other means of power besides steam), that in the same office may be found "letters broad" accompanied by drawings and descriptions, which may possibly render you less "at a loss to conceive what the *third* method is," provided you will take the trouble to look at them: though I cannot but consider it rather hard to be called upon for information on this head, after there had been for many months published, and after you had for, at least, three weeks, lying on your table a paper,[1] in which it is not unintelligibly referred to in the following words:—

"But even were the friction of the rarefied air against the inside of the cylinder to increase the power required ten times, as I have supposed, it is not imperative that the expense of transmission must be increased in a similar degree. Owing to its being well known and universally received, steam is the first mover, or power, Mr. Vallance has referred to. The researches of men of science in England have, however, been for some years directed to means of rendering the *gases* first movers, instead of steam, under the hope of obtaining an agent, which should serve as a mechanical first mover *without fuel*. From the year 1820, the attention of Mr. Vallance has been directed to this subject, with a view of rendering the method of conveyance the treatise refers to, perfect in the particular of cheapness of transmission; and about two years ago he obtained a Patent for a first mover, which will give *ten times the power of steam without any expence for fuel*, the principle of which is stated in the tract marked letter B, which I have obtained from him for the perusal of your Royal Highness." Now, really it would seem that you expect me to find you in *brains* as well as *matter*, for even with this statement of my having a "Patent for a first mover which will give ten times the power of steam, without any expense for fuel" before you, do you set your own, and attempt to set your readers' wits wool-gathering about a "tank 20 feet wide, four feet deep, and 390 feet long," the contents of which are to be boiled away in an hour,

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[1] Report to the Russian Government by a staff officer of engineers in their service, who was sent down by the Russian Ambassador to inspect my practical illustration of the method of pneumatic transmission I propose.

&c. &c. And had your eagerness to condemn not overpowered even regard for your own credit, you would have done *yourself* as well as well as me, the justice of asking to see "the tract marked letter B," instead of entering on calculations—and they too, erroneous (as are also some of your others) to a degree for which a schoolboy would be whipped—relative to a proposition, the very terms of which involve a result THIRTY TIMES GREATER than the effect you propose to produce.

It is therefore evident, independent of the proofs which other parts of your letter give, that you do not even comprehend the nature of my proposition; and that, in pronouncing upon it, you evince intellect of about the same calibre as that of the King of Siam, who disbelieved every thing the Dutch Navigator had previously told him, because he also said that in Holland, water became, at one time of the year, solid enough for men to walk on.[1]

So much as to your information and consequent ability for criticism, on points which are not merely *open* to the public, but which have been long *published* to the world in the periodical works devoted to subjects of the kind; and with reference to which, had you vouchsafed me attention at the time I *solicited* your investigation, before those who witnessed your first attempt at opposition, you would have been fully informed by myself. It is true these things are not noticed in my pamphlet: my object there being solely to render the *idea* apprehensible; and I even say "It would be at variance with the

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[1] The following extract from Mr. De Roos' Personal Narrative may be not inapplicable to the prejudices of those who exclaim "impossible," with respect to any thing that happens to be beyond their own personal knowledge. "On board one of them I saw what is called an 'Ice Boat.' It is about twenty-three feet in length, resting on three skates; one attached to each end of a strong cross bar, fixed under the fore part, and the remaining one to the bottom of the rudder,

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which supports the stern of the vessel. Her mast and sail are similar to those of a common boat. Being placed on the ice when the lake is sufficiently frozen over, she is brought into play. Her properties are wonderful, and her motion is fearfully rapid. She can not only sail before the wind, but is actually capable of beating to windward. It requires an experienced hand to manage her, particularly in tacking, as her extreme velocity renders the least motion of the rudder of the utmost consequence. A friend of mine, a Lieutenant in the navy, assured me that he himself last year had gone a distance of 23 miles in an hour: and he knew an instance of an ice boat having crossed from York to Fort Niagara (a distance of 40 miles) in little more than three-quarters of an hour. This will be readily believed when we reflect on the velocity which such a vessel must acquire when driven on skates before a gale of wind. These boats are necessarily peculiar to the Lakes of Canada."

Mr. De Roos is perhaps in error as to this last observation; a gentleman who called on me some time ago, having informed me he had gone 30 miles in an hour by the same method in Holland.

plan of this treatise, to attempt a *complete* demonstration of the practicability of the principle of communication it proposes. At a future period this may be done; but all that can at present be essayed, is to shew that there exists no insuperable impediment against rendering the principle available to our service, provided we choose to be at the trouble of doing it."

Now had you awarded me the justice of a full investigation, *prior* to fulminating your anathema, I should have been anxious to give you every information; and I appeal to yourself, whether in replying "most certainly" to your enquiry at the public meeting, I was not correct; as the discussion it would have given rise to, must necessarily have rendered you informed on those particulars, your ignorance of which invalidates your judgment.

Turning from these to other points of investigation, it is my lot to find myself dealt equally hard by, as relates to them also.

Among the subjects which have lately been much discusssed, railways stand eminent; and within these few years, there have been nearly a dozen new works published respecting them. But for the proof of your disposition to condemn rather than examine, which your *wilful* ignorance relative to the valves, the telegraph, and the power I advert to (cum multis aliis), so clearly demonstrate; the way in which you speak of rail-roads would cause me to presume, that in proceeding to state "what is daily performed on different rail-roads upon the usual construction," and "by loco-motive engines of known power," you were familiarly acquainted with those works; and that in adverting to them, I should be only recalling to your recollection names well known; notwithstanding that instead of quoting the ablest and most recent authorities, you refer only to an elementary compilation for the use of operative mechanics.

Of these publications on railways, three have attracted particular attention: Tredgold's, Wood's, and Palmer's. The first, on account of the science of its investigations; the second, owing to the statements of actual practice, with loads of from 20 to 50 tons weight, drawn by loco-motive steam engines, and the results of many years' experience which it records; and the third, from describing a new method of applying the principle of railway transmission: which new method, notwithstanding your "damning with faint praise," by saying of it, "whereas I am not aware a single rail-road on his plan is in use," may be daily seen in operation both at Cheshunt and Deptford; while, if you will go to Mr. Smart's Wharf, Pedlars' Acre, near Westminster Bridge, you may ascertain with what justice you exclaim against what I have stated about it, when you say "there is something so incredible in this," by yourself moving *two or three tons*, upon the short one Mr. Palmer has laid down there.[1]

It being desirable that practice should be referred to, I shall take the second of these works as the authority for the power required to move a load along a rail-way; and, turning to this publication, I find that Mr. Wood gives a chapter of thirty pages, detailing "experiments made on the friction and resistance of carriages moved along rail-roads;" which experiments refer to regular rail-way waggons, loaded with from one ton to nearly five tons.

After detailing the particulars of these experiments, he gives them in a tabular form; with reference to which he observes, "By the above table it will be seen, that the *least* amount of resistance is equal to the 219th part of the weight of the carriage; and the *greatest*, is equal to the 172nd part; and that the average of the whole will be about the two hundredth (204th) part of the weight."

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[1] "I am not aware."

"As who should say, I am Sir Somebody,
And, when I speak, let no dog bark."

So, because you are ignorant of what has been published, even in the newspapers, as well as in several monthly publications, you would have your readers suppose the principle has not been acted on.

While discarding, therefore, the effects produced on Palmer's rail-way as any authority, does it become evident, that assigning the proportion of power which *you* state to be necessary to move a given weight, as what is required in actual practice, would be equivalent to saying, that because the ponderous stages of former days required *six* horses to draw them through the miry roads of the period, at the rate of six miles an hour, it must be impossible that the coaches of the *present* day can be drawn ten miles an hour by four horses?

It is true that there are rail-roads so old and so badly laid down, that one-sixtieth (the proportion you assign) of the weight to be moved is the power required upon *them;* but on rail-roads, as *now* constructed, practice proves that one two-hundredth is enough; while Mr. Palmer states that on his, the result of many experiments proves that one three-hundredth is sufficient. The *two-hundredth* part will however be ample for my purpose. Had you done yourself, as well as me, the justice of examining, prior to condemning the practical illustration of my proposition which I have in operation here, you would have seen (to quote from the engineer officer's report you refer to) that "one of the peculiar advantages of the method Mr. Vallance proposes is, that it admits of the wheels of the vehicles which move in the cylinder, being *several times larger* than the wheels of carriages which run on roads, owing to their always being kept in an exactly perpendicular position, and consequently free from the strain thrown on the spokes of a common carriage-wheel by the deflections from the perpendicular which the nature of, and the obstructions upon roads, continually occasion: owing to this, the wheels of the vehicles which move in the cylinder may be from ten to twelve feet in diameter, or nearly *four times as large* as the fore-wheels of a coach."

Now, the profundity of your research causes you to deem this circumstance too unimportant to be even noticed. But as it is *possible* that it may not be utterly undeserving of attention by others, I will attempt to render the *justice* of your silence respecting it, evident by an observation or two.

Investigating the theory of "that part of the resistance which consumes the chief part of the moving power on rail-ways, — the resistance at the axles of the carriages," Tredgold says, " hence it is clear, that as far as the friction of the axle is concerned, if you double the radius of the wheel, you reduce the power necessary to move the carriage one-half; and so on of other proportions :" and again, " from these EXPERIMENTS it appears that the resistance does not decrease exactly one-half, by doubling the size of the wheels; but the difference is not more than one-eighteenth from that ratio."

In actual practice, and with a load of above thirty-six tons, Wood found that increasing the size of the wheels one-third, decreased the friction one-third. In other words, he found that with three-feet wheels, a locomotive engine would draw thirty-six tons thirty-six miles, in nine hours and thirty-five minutes; consuming in this period, and to do that work, 2534lbs. of coals; and that with four-feet wheels, the same engine, consuming the *same* quantity of coals, would move the *same* load 48. 8. miles; that is, above one-third farther, and at the respective rates of four and five miles an hour.

With practice thus supporting theory, I must take leave to consider the opportunity of increasing the size of the wheels, which results from the sides of the cylinder keeping them constantly in a perpendicular position, as a very important circumstance in my favor, notwithstanding that *you* deem it too insignificant even to be noticed.

The result of many experiments made by Wood on rail-way waggons, with wheels thirty-four inches in diameter, carrying from one ton to nearly five tons, is the conclusion, that on rail-roads *as now constructed*, the power necessary to move any load is less than one two-hundredth part of the weight of that load. The theory and practice referred to render it, therefore, a legitimate inference, that if with wheels of thirty-four inches diameter, one two-hundredth of the weight to be moved is the measure of the power requisite to move it, with wheels sixty-eight inches diameter, one four-hundredth of the weight to be moved, will be the amount of the power required; and that with wheels one hundred and thirty-six inches in diameter only one eight-hundredth of the power would be required.

With the case thus, as to the effect in diminishing the power requisite to move any load, which increasing the diameter of the wheels produces; and with the largest diameter I have specified, just equal to the diameter of the cylinder or tunnel you have criticised, I proceed to investigate in what proportion your calculations are erroneous. Adverting to a load of one hundred tons, you say, "the power necessary to move this would be, according to my estimate, 3920lbs., on a perfect level." It may be so by "your estimate;" but by Wood's *practice* it is only 1120lbs; and if that practice, and Tredgold's investigations and experiments on the subject are to be received, increasing the diameter of the wheels to the size of the cylinder, will reduce it to 280lbs; just *one-fourteenth* of what you assign.

Against this you will exclaim—but until you adduce *evidence* that the force of traction on rail-roads is *not* "inversely proportional to the diameter of the wheels," and disprove Tredgold's investigations and experiments, as well as Wood's practice, I shall deem myself entitled to the full benefit in point of diminution of draft, which will arise from the tunnel admitting of the wheels of the vehicles that move in it, being just four times as large as those of the rail-way waggons with which Wood ascertained, that the power required is one two-hundredth of the load to be moved.

You will doubtless urge lateral friction as a set off against this. Were it important enough to warrant amplification, there would be no difficulty in replying satisfactorily to you upon this head also. But as it would occasion a prolixity of detail, I have no wish to inflict, I dismiss it with the remark, that I shall have the most perfect confidence in leaving this part of the question, in the hands of any one who *knows practically* the effect of lateral friction between the side ribs of rail-roads, and the rims of the waggon wheels, (or vice versa, as flat or edge rails are used) and who will take the trouble to examine even the defective, make-shift apparatus I use to illustrate my proposition. Since any one so qualified would at once perceive, that in addition to giving the important advantage of concentrating the weight on one point, to a degree which even Palmer's principle cannot come up to, the *single line of rail* in the tunnel not only may, but unavoidably *must* be kept clean, in a way which will at all times render the *minimum* of draft fully effective.[1]

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[1] Few persons are aware how trivial a circumstance will materially increase the power required on rail-ways. In his investigations on rail-way transmission, Palmer observes "If a plane be perfectly hard, smooth, level, and straight, and the wheels of a carriage perfectly hard, smooth, and cylindrical, the motion of such carriage would be impeded only by the resistance occasioned by the friction of the axles," and "the

In addition to this advantage another would arise from the power always *operating more truly* in the line of motion than it can do on any other railway; since the operation of the air can be so arranged, as for every carriage, let the string, or line, be ever so numerous, to be moved forward, not in consequence of contact, or connection with those before or behind it, so as for curves to interpose an angle between the first and last carriages of a line or string; but by the action of the air between it and those immediately preceding

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smallest protuberance on the surface, if it be sufficient *to change the direction* of the motion, is an impediment." "The resistance from *dust* is greater (Tredgold says) than would be expected. Mr. Palmer made an experiment to ascertain its effect on the Cheltenham tram road, from whence it appears that it required 19½ per cent. *more* power to draw the same carriages, when the rails were *slightly* covered with *dust*, than when they were swept *clean*." To avoid the impediment thus arising from *dust*, Palmer states, that "on the edge rail-way at the Penrhyn slate quarries, the rails of which are convex on the surface, it is usual to carry a butt of water before the train of carriages, which sprinkles the rails in its progress, and washes their surfaces," and "the same practice is not *uncommon* on tram ways, but those require it in a greater degree." Now not only would the *single line of rail-way* I use in the tunnel, be sheltered from the impediments common rail-ways are subject to, in consequence of "the surface of the rails being near the ground, they are necessarily exposed to *dirt* and other extraneous substances lying upon them;" but also, owing to the rate at which the air would move in the tunnel, so strong a wind would be raised as to *prevent even dust from settling on it.*

or succeeding it, in consequence of which, the line of motion and the line of impulse (of immediate impulse, i. e.) will be always the same, a circumstance that cannot possibly take place on other railways; and with reference to which, Palmer's principle has the disadvantage of being trivially more exposed to it than any other. Owing to these things, lateral friction will be *more* than made up for, and the whole of the important balance in my favor, arising from the degree in which the diameter of the wheels can be increased, may be carried to account.

I sum up, therefore, on this part of the question, by saying, that if the calculations you have made, as to the power necessary to move any weight along the single line of rail I propose in the tunnel, and the inferences you have drawn from them, are rectified by being divided by 14, the result will express the *real* force of traction necessary to draw the loads you have adverted to, along that rail-way.

I do not proceed to apply this diminishing number to the results and aggregates you have given, any further than to observe, that as only one-fourteenth of the power you have stated will be required, only one-fourteenth of the degree of exhaustion (or vacuum) need be produced; and, in adverting to these two points, I have, therefore, a less difficult task to perform than I acknowledge would have been my lot, had the case really been as you state it to be.

From a misconception I should be surprised at, but that the astonishment it excited merged in other more astounding mistakes, you charge me, at page 16, with encouraging the delusion that, "under a very considerable less degree of exhaustion than a complete vacuum, any load may travel with any velocity you please;" for proof of which you refer to page 47 of my pamphlet.

Now, as it happens, the degree of exhaustion I there refer to, is *specific*, (equal only to the three-thousandth part of a vacuum) and as it is well known that, under the pressure I mention, (37 grains per square inch) air will move at the rate of only about 12 miles an hour; while my words are "a load of ten tons, is what scarcely any waggon would bear, and hardly any team draw; yet would a load of this kind be carried rapidly along by a pressure so trivial as to be imperceptible"—with misconception thus guarded against, by the pressure being distinctly *specified*, and with the term "rapidly" evidently used in comparison with the rate at which a waggon loaded with ten tons would be drawn by horses, I cannot but surmise, whether the exposition you have there so kindly favoured the world with, as to the "motions produced by atmospheric pressure in exhaustion," may not be read with equal benefit by yourself, as by any one; particularly when, after totally omitting to take into consideration the important effect which momentum (as well of the air itself, as of the vehicle) would have in modifying the motion, and preventing the stoppage of the carriage, in the way you describe at page 21, you exclaim "this then is a true philosophical explanation of what will take place in the action of a carriage impelled by atmospheric pressure."

Against such philosophy as this, I protest, in justice both to myself and the public. As the basis of lectures delivered at your Mechanics' Institution, where

> ———"words of learned length, and thund'ring sound,
> Amaze the '*operātives*' rang'd around,"

it may have sufficed. But when held up as a criterion by which the public mind is to take its tone for my condemnation, I am obliged to pronounce it philosophy of which you ought to be ashamed.

The velocity consequent on any degree of exhaustion, can be assigned with precision; and had the question reference only to the passage of air through an aperture, might be exhibited, as tables of the rarefaction incident to any particular altitude are given. But when the passage of air *under different degrees of rarefaction* through tubes, is involved in the consideration, I feel it best becomes me to proclaim, that as I found the experiments I considered necessary to the full investigation of the question were beyond the means of an individual, I know nothing on the subject (applicable to high velocities) that I can depend on; and should be under obligations to any one who can inform me whether there is extant any thing with reference to it, that will admit of correct inferences being drawn, as relates to velocities exceeding five or six miles an hour.[1]

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[1] Since this was written, I have had the pleasure of Professor Leslie's company for three days. Not having seen him since I began my practical illustration, I was solicitous to have the benefit of his witnessing its operation; and have the satisfaction of finding he considers the practicability of the principle sufficiently proved to render it a simple money question; and the only point for present consideration to be, whether it will *pay* to put it in practice between Brighton and Shoreham: just as a railway or canal question would be considered.

Although aware of what were his previous views, as to the friction of air in tubes, yet, as he might have obtained additional information on the subject, I asked him about it. His reply, however, was to the same effect as one I had previously received from Mr. Davies Gilbert—" that we have no data from which to calculate respecting it."

Yet do you, in adverting to the power required, and to the increase of it, which friction will render necessary, remark, "Mr. Vallance does *not* notice this:" at page 27, you say, "the necessary power to be required, forms *no part* of the consideration:" and, at page 32, you proclaim, "OUR PROJECTOR does not give any *idea* of what the power will be, which will be necessary for his work." Unfortunately, however, for your accuracy, pages 69, 70, 71, 72, 73, and 74, of my pamphlet, treat expressly on this part of the question.

It is true, I do not specify the *amount* of power required; not, however, as you say, because it "forms *no part* of the consideration;" but because I know no data from which to estimate it. Had the reference been to any given weight to be moved at any required rate, it would have been easy to assign the power necessary, even to a fraction; but involving considerations, with reference to which I know of no data to calculate from, instead of hazarding any estimate, founded on the very little knowledge I possess as to the friction of air, *under different degrees of rarefaction*, when passing through tubes, I at once acknowledge my ignorance, and state, that I do not see "that this circumstance can be ascertained otherwise than by practice;" nor is it my good fortune to find in your pages any information on this, to me, unknown (and very important) subject.

True though it be therefore that I do not attempt to assign the *amount* of power required, yet is it owing to the rule I lay down at page 45, where I say, "it would be at variance with the plan of this treatise, to attempt a *complete* demonstration of the practicability of the principle of communication it proposes. At a future period this may be done; but all that can at *present* be essayed is, to shew that there exists no *insuperable* impediment against rendering the principle available to our service, provided we choose to be at the trouble of doing it."

Yet with these observations on the very question, do you say Mr. Vallance does *not* notice this; and that it "forms *no part* of the consideration."

Leaving to others to decide on the accuracy of these remarks, I proceed to your other observations on the subject of power.

One of the objects in writing my pamphlet being, not to introduce such extraneous matter as should prevent my friends from reading it, I referred only to the universally known mechanical agent, steam, as the mean of power; with reference to which you charge me with giving "a most exaggerated statement of the powers of the steam-engine." Now, as the statement I gave was taken from the published monthly reports of the persons appointed officially to record the work done by the engines referred to, I must observe that in proclaiming it *exaggerated*, you proclaim what is not true; that statement being taken from a copy of the official report given in the Philosophical Magazine for July, 1816. And as the explicit manner in which I have given it, and the caution I evince in calculating only on the official statement, render the way in which you sink the authenticated, and refer only to the *reported* statement (to say the least) of questionable import, I feel it necessary to quote the passage.

I advert to two of Woolf's engines: one in Wheal Abraham, and one in the Consolidated Mines. On the authority of the official report, I state, that in May, 1816, the engine in Wheal Abraham mine did work equal to that of above twenty-nine horses for an hour, for every bushel of coals it burnt.

Of the other engine in the Consolidated Mines, I observe, "and it is now *said* that another engine of his in the Consolidated Mines raises 87,360,000lbs. one foot high, with every bushel of coals burnt; which is equal to the work of 45. 5 horses for an hour with one bushel of coals. Now, as this last statement is not, like the other, official, we will calculate only on the prior unquestionable one."

But notwithstanding the caution I have thus evinced, you refer *only* to the statement I reject, and do *not* notice that which I calculate from. I can say no other therefore than that the motive under which you do so must be a questionable one.

Nor is this the only proof of your candour with reference to the same passage.

You remark that "this mode of travelling, supposing it were practicable, (a most extravagant supposition) is more expensive by far than any plan now in use; and incomparably greater than what might be effected by common rail roads and locomotive engines." Mr. Vallance "lays some stress upon the greater expenditure of coals in a locomotive engine, than in a fixed one. Suppose it is so, suppose it is double, what is that compared with the infinitely greater power you will require in the fixed one?"

Now, looking at the above assertions, any one would really imagine I must have represented the degree of saving by fuel, by large *stationary* engines, in comparison with locomotive engines, as only somewhere between one and two, whereas my words are, "and contrasting it with what is stated to be the effect of locomotive engines, we cannot but perceive that should means, by which large stationary engines could operate to move vehicles from one place to another, be devised, a bushel of coals would go so much farther than it can do in locomotive engines, that the mere expense of transmission might not be much more than one-tenth what it would be by locomotive engines."—*Vide Appendix.*

Nor are you free from liability to censure in saying "equally unsatisfactory is he in his statement of an air pump, eleven feet in diameter, which can exhaust 22,000 cubic feet of air per minute—he does not tell us where it is, nor what power is used to work it:" for had you but taken one hundredth part of the pains to examine that you have to condemn, you would have discovered the *locus quo*, and seen that the air pumps *I have in use*, are above eleven feet in diameter; and capable of exhausting much *more* than 22,000 cubic feet per minute!

With accuracy no wise superior to this, do you at page 29, observe, "and Mr. Vallance himself says, that he is able with his single power to exhaust 50,000 cubic feet per minute, for which Mr. Couling requires the power of 105 horses." Now had you given the page where this is taken from, it is *possible* I might be able to find it; as it is, I am obliged to reply, *it is not in my pamphlet:* "I do not find it; 'tis not in the bond."

Also do you say at page 68, "Mr. Vallance cannot be blind as to the actual power of his model, and he can only deduce from the facts which that gives, what can be done on a large scale; and with these facts staring him in the face, can he say that goods may be moved at a cost of material of only the 25th part of a farthing per mile; or to make this more intelligible, that 100 tons may be transported through his proposed tunnel, between Brighton and Shoreham, supposing the length six miles, at a cost of sixpence."

Now to this I have to reply, not merely that I say no such thing; but also, that the *lowest* sum I do specify as the necessary charge for conveyance, is three hundred times greater than this *assertion:* in other words, the *lowest* charge I mention for carrying goods between Brighton and Shoreham, will, on 100 tons, amount to £7 10s., instead of the sixpence you state; while the very leaf whereon I say this adverts to charges, one third (and even *twice*) greater!

You may, therefore, well be, as at page 54 you say you are, "utterly at a loss to conceive upon what calculation, and from what data Mr. Vallance has come to the conclusion, followed by the Chevalier Couling, that goods may be conveyed at scarcely any expense;" for certainly neither Sir William Couling nor myself ever came to any such conclusion, our reference (and indeed our words) being to the mere expense of *power*, and not to the aggregrate expense of *carriage*,[1] which I conceived sufficiently indicated by separating the two, and confining the expense of power to the *twenty-fifth part of a farthing per ton per mile*," whilst I state, that "the price of *carriage* from Shoreham to Brighton, might be reduced from more than *one shilling*, to *three-pence* per ton per mile." And yet, after maligning my object, and thus misrepresenting my statements, do you exclaim, "in what I have said, I have been anxious to avoid giving Mr. Vallance any cause for being offended."

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[1] "The expense of conveyance is compounded of the original cost of the means which are employed, the cost of the repairs to which it is liable, the expense of transporting the articles, or overcoming the resistances to which their motion is exposed, and the cost of loading and unloading the same."—*Palmer's Observations on Rail-ways.*

Exulting in the success of his machinations, Glo'ster says of himself, "I do the wrong, yet first begin to brawl;" and as I cannot conceive but that my having sent you a copy of my pamphlet; secondly, most readily complied with your request to see my practical illustration; and thirdly, not been deficient in the urbanity due to every gentleman at the two public meetings—at least those witnesses to whom I have appealed, assure me so; and I never saw you but these three times—as I do not perceive but that deportment of this kind, ought to render me free from any charge of want of courtesy, I cannot but apply to your observation, "I endeavour to keep my language within bounds; for though I do not feel that I am indebted to Mr. Vallance for any courtesy, I would fain shew it him," the observation which Glo'ster applies to his own conduct towards those he injures. But to resume:—

Your asseveration, at page 35, "for I do assure you, Sir, these difficulties accumulate wonderfully upon my hands as I proceed," induces me to suggest less economy of arithmetic, the next time you take up any question of this nature; for had you consulted your multiplication-table, you would have found your surmise, "I think it might be demonstrated what power might be necessary," true to a degree that would have admitted even of a school-boy telling you that my statement, at page 31, is sufficiently accurate to be depended on, as to the loss of power which would take place in consequence of the space I purpose leaving between what will serve as "piston" to the carriage, and the tunnel. In the practical illustration I have in operation, this space or crevice is purposely above an inch wide; and equal, in the whole, to an aperture of nearly *three square feet:* yet does it not prevent the carriage, with eight or ten people in it, from springing forward to the impulse of the air pumps with a readiness I did not expect, and was surprised at. You may, therefore, allow yourself the satisfaction of dismissing the *doubt* you so kindly express on this particular at page 35.

The points you next *doubt* upon—"how passengers and goods may be taken up and set down," and "during the process of exhaustion how long would it be before the air becomes equalised," the effect which the state of the weather, showers of rain, sunshine,[1] and the other "many extraordinary circumstances you mention would have, I shall no further notice than to say, I pledge myself to be prepared on all these points to the satisfaction of every one, as soon as the completion of the tunnel between Brighton and Shoreham renders it necessary they should be ready. But that the whole of the suggestions you have so kindly offered may not be lost, I have already given directions for the preparation of twelve gross of tinder boxes, as a precautionary measure againstthat "most dreadful situation" you advert to in page 50: on the whole of which is to be inscribed " Provided at the suggestion of Moses Ricardo, Esq." that every one may know to whom they are indebted for so profound a precautionary measure against a light going out.

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[1] The nature of these "extraordinary circumstances" recalls to my recollection, as not inapplicable to your criticism,

"While some aver that all this clatter
Is nothing but a *moonshine* matter."

True to the system of mis-statement with which you set out, at page 42, adverting to the *ultimate* application of the principle which I have supposed—the rapid concentration of troops on any threatened point—shutting your eyes to the self-evident expedient of sending off load after load as they march up and get into the carriages, you purposely create the difficulty of having all to send at one time, and in a string of carriages (as you say) fourteen miles long. As however this difficulty could have arisen no where excepting in a head whose object was to create them, I notice it, not to refute it in detail, for that would indeed be useless, having no such proposition before the public; but merely that my friends may see I have not stated any thing impossible, even in this climax of my presumption.

You say that it is "physically impossible to move 100,000 men simultaneously by atmospheric pressure in a tunnel of that dimension." It will be admitted by every one that 100,000 men will not weigh so much as 10,000 tons. A weight of 10,000 tons is equal to 22,400,000lbs. 22,400,000lbs. divided by 200 (the proportion of power necessary on a horizontal railway when the carriage-wheels are only 34 inches diameter) gives 112,000lbs. as the pressure required to move 10,000 tons; and 112,000lbs. divided by the area of the tunnel, gives rather more than half a vacuum as the degree of exhaustion necessary to move that weight, at whatever rate the air is pumped out of the tunnel.

But though I have adverted to wheels of only thirty-four inches diameter, and with which a two-hundredth is the measure of the power required to move any weight, to shew that even under the most unfavourable circumstances, your statement as to "physical impossibility" is erroneous;" yet do I not mean to omit the important and exclusive advantage arising from the *very high* wheels which the nature of the tunnel will admit of being used. And as this will diminish the moving power, and consequently the degree of exhaustion to one-fourth of what I have stated, only one-eighth of a vacuum will be necessary, which would sink the barometer from above *very dry* to below *stormy*: a degree of rarefaction in which we could exist without difficulty, or being all "hors de combat," as you so facetiously imagine, even were we, as you most erroneously suppose us to be, exposed to it.

At page 45, you say, "I am persuaded that the power necessary to be provided would exceed not only that of all the engines in this country, but the whole world."

The aggregate power of the steam-engines in this country, is considered to be equal to that of above 200,000 horses; and in an address delivered by M. Dupin at Paris, in 1824, he stated that the steam-engines throughout the whole world do not represent a power superior to that of 400,000 horses. Now, calculating from the datum which Tredgold's investigations and experiments, and Wood's practice, have established, "that the moving force is inversely proportional to the diameter of the wheels," (those I propose using being 11. 3 feet) the necessary power for moving 100,000 men at the rate of 100 miles an hour, would not (independent of the friction of the air) exceed 10,000 horses; an amount that will leave 190,000 horses' power unappropriated in England alone. And even were the case to be as Sir Wm. Couling has supposed, that the friction of the air were to increase this power ten times, still should we have a surplus power of 100,000 horses.

But were the case to be really as you state, what has this to do with the merit of the proposition I do make? in comparison with which, what you so erroneously state me to propose, is indeed, as you say, "Mount Ætna to a Mole-hill." The same argument might have been used with equal justice against the first *canal, coach,* or *steam-vessel;* that propositions for neither of these were to be entertained because the general accommodation would require *more* canals, coaches, and steam vessels, than happened to be at that time in the whole world: they were found to be profitable and hands enough were found to make them. So I apprehend will the result be with regard to power for the question before us, whenever its advantages shall be proved by actual practice between Brighton and Shoreham. To a "lover of science" it ought to be rather ground for congratulation than *ridicule;* more particularly as relates to the "operatives" who experience the benefit of your lectures at the Mechanics' Institution; in reference to the additional occupation it would afford to artizans and the labouring classes.

It is observed by a writer on *prejudice*, that it is

"Too much for any one to boast
The right in *every* contest; if in most."

Yet with an inveteracy of the "mental eye," for which I do not envy you; it appears as if you were determined to perceive nothing but what deserves reprobation in all that I have attempted to do. As soon as I became convinced that it was possible to convey ourselves so much faster than we now can do, as the principle I advocate will admit of, I saw that it was essential to the operation of that principle, that a mean of communication independent of, and more rapid than itself, should be arranged to operate simultaneously with it. For this purpose I invented the mode of telegraphic communication described in the last section of my treatise on Insular Defence; which, let it *prove* inefficient as it may, at least *appears* to possess an important advantage over all present methods of telegraphic communication, from being equally efficient at those times when they are useless;—in foggy days and at night that is; and from the impenetrable secrecy, and greater extent of its communications.

Forgetting however that even "a fool may now and then be right by chance," you treat this proposition as you do the other; and notwithstanding that I describe the principle as applied to Brighton and Shoreham so specifically as for those places to be named sixteen times in the section, yet do you first represent me as proposing its application on lines from ten to twenty times longer, and then conclude by attempting to put it down by a ridiculous comparison instead of by argument; arraying all the objections which the candid examination I endeavour to give the subject, puts into your hands, and then evincing the fairness of your criticism by so entirely omitting to notice my replies to those objections, that your readers not only can have no idea that they *are* already answered, but must also suppose that they cannot be replied to. Unfortunately however for the credit of your investigation, the length to which I have proposed the application of the principle, not being so great by half as that of a continuous line of pipe through which we *already* force water by operating on it at one end, in a way which is, in effect, the same as what I propose as to this mode of telegraphic communication, it is at least certain that there is nothing impossible in the principle; and only the contempt with which you have passed over the details, and consequently not perceived how difficulties of execution may be guarded against, can have made you say what you do say against it, since the description I have given, points out very fully how the whole of the causes of derangement you mention may be guarded against.

With a wilfulness at which, under the present state of the railway question, we may be surprised, you say, "in drawing a parallel between this tunnel and a railway, we shall find that all the advantages will be on the side of the latter." Had this been written two or three years ago, there might have been some excuse for it, owing to its not then having been proved how baseless was the railway mania that prevailed. But with one of their most efficient advocates, and who states himself to have had daily opportunity of witnessing their performance for nearly eleven years, (Wood) saying, " It is far from my wish to promulgate to the world that the ridiculous expectations, or rather professions, of the enthusiastic speculist will be realised, and that we shall see them (locomotive engines) travelling at the rate of twelve, sixteen, eighteen, or twenty miles an hour (on railways): nothing could do more harm towards their adoption or general improvement, than the promulgation of such nonsense." With Tredgold (who is also their professed advocate) expressing himself to the same effect;—with Palmer, totally silent as to any rate exceeding two and a-half miles an hour;—and with a fourth writer, who investigated, with the most anxious desire, to come to a correct conclusion on the subject, stating positively that "there is no instance of any locomotive engine having (regularly and as a constant rate) travelled faster than, if so fast as, six miles an hour"—with those who have most investigated the subject pronouncing thus upon it; and with the operation of the Stockton and Darlington railway[1] confirming these opinions, I am at a loss to conceive how, even with the aid of that profound compilation, "Nicholson's Operative Mechanic," you can screen yourself from the charge of the veriest ignorance, when you say, (page 62) "I do not know why we should limit our speed any more on a railway than in a tunnel; there is a limit to that of a horse, but not to a locomotive engine; and if it be desirable, which I very much question, that we should move along with this immense velocity, *it is perfectly practicable on a rail road!*"

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[1] When Sir William Couling was here examining my practical illustration, he told me that he had inspected the Stockton and Darlington railway, and witnessed the effect of the locomotive engines upon it;—that as related to convenience of transmission and reduction of the expense of transit, it answered very well; but that it did not, nor ever could answer

Now had your competence borne any comparison with your presumption, you would have seen that for reasons such as are adverted to in the extract from a pamphlet on railways, published between two and three years ago, (vide appendix B), the actual state of the case is the very reverse of what you describe, the limit to the speed at which a

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as a route for *persons* in preference to stage-coaches; in that the average speed of the locomotive engines was but little faster than he could walk: and at the very time of his inspection, was a delay of some hours occasioned by the far from uncommon occurrence of the wheels of the locomotive engine having run over the rails, and drawn five of its train of waggons off also; a circumstance which occurs much more frequently when the waggons are drawn by engines than when drawn by horses; which always stops up the road for the time; and which, in the instance Sir W. C. saw, could be remedied only by taking that part of the railway up to admit of the engine being replaced on the line.

locomotive engine can go being less, and that too materially, than the rate at which horses will draw us; and from the liability to upset which must attach to every vehicle of from five to ten tons weight, which moves rapidly on a track in which it is not prevented from upsetting, (as would be the carriages in the tunnel, owing to the top of it keeping them down, and rendering their *turning over impossible*[1]—owing to this, locomotive engines cannot, on an *open* railway, ever be driven so fast as horses will draw us; though in a covered one they might: a circumstance which will serve to insure those who advance money for what I propose between Brighton and Shoreham, against that money ever being lost; since were the tunnel entirely to fail as relates to pneumatic transmission, or propulsion by the pressure of the atmosphere, still would the work be efficient as a railway, on which goods might be drawn several times faster and more cheaply than they could in any other railway.

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[1] "On a common road, the great resistance at the surface of the wheels, and the force of the moving power, tend to keep the carriage from upsetting; but on a railway, the smallness of the moving force, and little increase of resistance to the wheel which takes the stress, render them insufficient to balance the momentum the carriage requires by striking on an obstruction."—*Tredgold.*

It is possible, therefore, that your statement at page 63, as to locomotive engines conveying a hundred tons from Brighton to London in three hours, &c. &c. may be just worth the paper it wastes; and that your enquiry "why then should we abandon rail roads, the effect of which is so well known, and substitute the tunnel," may remain a memento of your wisdom, and the depth of your research, till time consigns it to a gulph, which, deep as it is, it yet may be doubted whether it can possibly be deeper, than the profundity you evince.

Before I conclude, you observe, "I must take some notice of Mr. Vallance's Working Model, upon the operation of which is founded those high encomiums which you and others have lavished upon that gentleman."

In observing upon this, with the same obliquity of mental perception which is so evident throughout your whole investigation, you have seen only the *bad*, and overlooked all the *good* parts of the case—stating that "upon this imperfect model he has founded the practicability of his plan;"—that I cannot plead it is in a faulty state, nor possibly expect upon a large scale to make it as perfect as this, &c. &c. Now though not only not blind to the defects of this practical illustration of the principle of transmission I have proposed, but also more sensible of them than any one else can possibly be, owing to the way in which they have been forced on my notice—though thus aware of its defects, yet do I, notwithstanding, expect, and that too with a confidence which would lead me to stake my life on it, were such a proof necessary, of my own conviction to make it upon a large scale, not only "as perfect as this," but very much more perfect; owing, as well to the nature of the case, as to the experience I have derived from the operation of this.

In reducing a theory to practice, it is frequently found that it can be much better done on the large, than on the small scale. For proofs of this, I advert to the working models of steam engines made by philosophical instrumental makers: which require a nicety of execution as superior to that of the practical steam engine, as the work of the watchmaker is superior to that of the millwright; for it is well known, that according to the magnitude of a steam engine, are leaks, and other defects of execution, more or less important; an untight joint, which would render a small one inoperative, acting only as a trivial impediment to a large one. So is it with chronometers; an inaccuracy of execution, which would actually prevent a watch from going at all, being quite unimportant in a church clock.

And so it is as relates to pneumatic apparatus; for different as it is from the general opinion, in consequence of no one having operated on so large a scale before, yet is it the case, that the larger the scale on which pneumatic experiments are made, the easier is the execution provided proportion of parts be properly observed; and the means commensurate with the end.

Owing to the novelty of the operation, I deemed it advisable, when I had decided on demonstrating the practicability of my proposition on a scale capable of carrying persons and goods; and which should reply to objections that would be urged as to the power of exhaustion, the proportion and effect of the vacuum, &c. &c., by admitting of the querists convincing themselves, from actually experiencing the operation of the principle—I deemed it advisable to get the work constructed by practical engineers of the highest name and reputation.

To my great surprise, however, they declined to have any thing to do with it, on the ground of "impossibility;" and with motives the most friendly towards me (and most honorable as relates to themselves), refusing, because they would not derive profit from undertaking an experiment which they were satisfied it was impossible should succeed, *even as an experiment.*

In consequence of this repulse as to the course I wished to take; and that too not from one or two, but from several—I was obliged to have it executed under my own directions. In the course of this execution, I found, as I had expected to find, but had vainly attempted to cause them to see I should find, that the magnitude of the scale of operation, when the means to be made use of were properly adapted to the end, instead of *increasing*, most materially *decreased* the difficulties of execution; and strange as it may appear, and unexpected as it was by me, the principle was actually proved, and persons conveyed by its operation, before my air pumps (of 12 feet 6 diameter) were finished; and when the (otherwise open) tops of them were covered with nothing but half-inch boards laid over them; as a carpenter would lay the floor of a room; and that too without the boards being even nailed down; and when there were between some of them crevices through which you might thrust your hand. I entertained no idea of their giving motion to the carriage in this state; having them set to work, solely to try how a certain part of their machinery would act; as an artizan would offer any thing to the place it was intended for, to see how it would fit. And similar do I find the case as relates to another circumstance.

We are enabled to see in the tunnel I have made, in consequence of windows in it. A chance circumstance renders the mark these windows hold out, so irresistible a temptation to the idle boys of the neighbourhood, that every day some of them are broken by the stones these varlets fling. Yet does the air which rushes through the holes thus made, so little derange the operation of the apparatus, that we never take the trouble to stop them till the experiment I may be trying is over, and the glazier consequently can repair at leisure.

Defects, therefore, which would give rise to insuperable impediments had I tried the experiment on a *small* scale, are evidently (and solely in consequence of the magnitude of the scale) of no consequence. Now, similar would the case be found, in rising from experiment on the scale of actual practice, to practice itself.

The cylinder (or tunnel) I propose between

Brighton and Shoreham needs not, as relates to diameter or size, be larger than the one I have in operation. The air-pumps I have in use are large enough to exhaust one million cubic feet (about the contents of the proposed tunnel) in half-an-hour; and they are capable of working under pressures which would move loads equal to those drawn by locomotive engines (thirty to fifty tons) at once: they are therefore fully practical.

The information (or experience) I have gained, from operating with them in the tunnel I have in use, notwithstanding your sneer and assertion, that it "can be no guide to me," is such that I would pledge myself to lay down a tunnel of the same diameter between Brighton and Shoreham which should be equally air-tight as a new ship is water-tight; that is, the leakages of which should be of no greater importance than are the leaks experienced in a new ship, and which should occasion no greater a proportionate waste of power than do the leaks incidental to every vessel.

This tunnel I would engage should be sufficiently true to prevent the passage of any quantity of air that should prove at all important, between it and the end or "piston" of the carriage or carriages that moved in it. Instead therefore of the case being as you state it, that "I cannot possibly expect, upon a large scale, to make it as perfect as this," I know that I can make it much more perfect."

You, indeed, whose intuitive perceptions are so free from the leaven of error to which my humbler faculties are subject, might perhaps be able to make it *just as well* without the aid of that experience which operating on the practical scale, gives. But (even though it should be to my shame) I must acknowledge that I did not know so much before from theory alone, as theory and practice combined have taught me; and that I feel much more competent to the execution of the work between Brighton and Shoreham now that I have their joint instruction, than I was before.

It is true that with reference to the tunnel itself, there is but little improvement necessary; it being as tight as I could wish it for the purpose intended, and strong enough, weak as it seems in your opinion, to admit of above one thousand tons being moved in it at one time.[1] But in respect to durability and the strength requisite in a structure in which heavy goods are to be conveyed, not once, and in the way of experiment, but daily, and for many years, in these particulars it is evident important improvements may be made.

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[1] It is strong enough to bear a concentric pressure of several pounds per square inch. The area of its diameter is equal to 6362 square inches: a pressure of two pounds per inch on this area would move above 1000 tons, even in the ratio of 1,200th being the power necessary; while with wheels of the size the cylinder will admit of, nearly 3000 tons may be moved by that pressure.

The air pumps also, though large enough for the conveyance of goods between Brighton and Shoreham, and capable of practical application to such a purpose for a short time, are yet not so constructed as would be necessary for purposes of durability; so that much improvement would be made in this particular. In the method of connecting them with the tunnel, important improvements might also be made.

Lightly as you hold the practical illustration (or "working model," as you term it,) which I have in use, yet have I learned, and daily do I learn, much from its operation. Although fully aware, in constructing it, that it was desirable the valves and apertures through which the air would pass in its passage to the pumps, should be as large as possible, yet did I not expect but that a diameter one-half that of the tunnel, would have been sufficient; as I knew that no velocity above a few miles an hour could be attained in it: and as it was very inconvenient to have them larger, they were made only one-half the diameter of the tunnel. But I find that the effect which the increase of velocity this occasions in the air, absorbs power to a degree which renders necessary valves of a different kind for the proposed tunnel between Brighton and Shoreham; and which should occasion no greater velocity in the air when passing through them, than when moving along the tunnel.

In the notice you have taken of what you term "Mr. Vallance's working model," true to the conceit which misleads you throughout, you deem yourself quite competent to condemn from intuitive perception alone; and it being impossible that you can be mistaken, you issue your fiat accordingly. But had you examined, previously to thus committing yourself, you might have learned that though it be true that much more power is necessary to move the carriage in the tunnel by the operation of the air, than is requisite merely to draw or push it on the railway, yet does the loss of power arise from circumstances that are extraneous, and which would not apply to any practical application of the principle.

By a process of calculation you deem conclusive, but with an accuracy by no means enviable, you say, "I am certainly not overrating when I assume that a power equal to three horses is exerted: so in this tunnel *with no extra friction*, perfectly straight, perfectly level, no risings or turnings, and of only 150 feet length, or 140 feet, on which the carriage moves, a power of three horses is required to impel *half a ton* forward, at the rate of two miles an hour; and of this 4-10ths is required to withdraw the air, and 1-10th the load; or somewhat about 100lbs. to move half a ton!"[1]

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[1] Your powers of computation are certainly of an inscrutable order, and entitle you to the most distinguished office in the Exchequer of Barataria. Independent of the accuracy exhibited by your estimate of the amount of the pressure of the atmosphere on an area of 100 feet—in your lucubration as to the contents of the tank or canal your P.S. mentions—and your equally accurate calculations as to the gallons of water the quantity of steam you advert to would require—independent of these, the general profundity of your powers of computation is astonishing. Scarcely any thing is more generally known among those who have any pretensions to the power of discrimination on such subjects as this, than the number which expresses the power of a horse; it being now almost universally received, that supposing a horse of average powers to be constantly employed in raising a weight, the effect he produced would be equal only to about 150lbs. raised 220 feet for every minute he worked: and a horse's power is consequently expressed by 150×220=33000, or thereabouts. Boulton and Watt express it by 32,000, Woolf by 36,000; and indeed by all who now write upon it (excepting Wood) it is expressed by some number varying from 30,000 to 36,000. Palmer pronounces it 33,000; Tredgold 33,333 (or 16,000,000lbs. raised one foot in a day's work of eight hours); but Wood only 24,640.

Yet does your *superior knowledge* cause you to render your calculations (adverse to me as you mean them to be) just two-thirds less adverse than they would be, had you calculated from

Now had you done yourself as well as me the justice of accepting the offer (indeed request) I publicly made you, to examine my practical illustration, you might have seen, first, that though there are, as you say, two steam engines on the premises, yet one only and that of only one horse power, (a little condensing engine of six inch cylinder and 18 inch stroke) is used to move the carriage —the engine (an old second hand one) which I first put up for the purpose, having proved so defective as to be capable of doing no more than work the pump which supplies the condensation water; nor is it used for any other purpose; and but that the situation of the well renders it at present unavoidable, it would not be used even for that.

Secondly, you would have seen that your expression "this tunnel with no extra friction," is indeed an unhappy one, to any person who has regard for accuracy of examination; there being, in comparison with the power, a hundred times more friction as relates to "this tunnel," than would be the case in practice.—Strange as you may deem this assertion, yet is it true. The air pumps I use are

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a correct datum as relates to what a horse can do; the statement of his power which you have given at page 24, being two-thirds greater than it ought to be.

three in number; and capable of exhausting 40,000 cubic feet a minute; or say one million cubic feet (the contents of a tunnel eight feet diameter, extending from Brighton to Shoreham Harbour) in half an hour. They are strong enough to produce a pressure equal to above one eighth of an inch of mercury on every square inch of surface the end (or piston) of the carriage exposes to the action of the air. A pressure equal to an eighth of an inch of mercury, would move thirty-five tons at one time in the tunnel, even were the wheels of the carriages only thirty-four inches high, while the height these wheels will actually be, may admit of such a pressure moving three times that amount.

The weight of the moving part (or as it may be termed "piston") of each of these pumps is about a ton, and their friction is very considerable, independent of the friction of the machinery by which they are driven; yet are they, all three, set in motion by a little one horse steam engine; which bears no proportion in point of size, with the bulky and ponderous masses it moves; and which, no one who did not actually witness it, could conceive capable of working them.

But this is not the only disadvantage which this practical illustration "with no extra friction" labors under. In supposing the principle applied practically, steam engines and air pumps at each end of the tunnel are necessary; to admit of conveyance either way. Now had I resorted to this expedient, to prove that a vehicle could be moved thus in my practical illustration, I must have been at much greater expence than I could afford. As a matter of economy, therefore, I made one steam engine and set of air pumps answer my purpose, by applying to the tunnel a pipe and valves, which have a similar operation and effect to the eduction pipe and valves of a steam engine.

But this expedient, though quite to my purpose as relates to *economy*, is decidedly adverse with regard to effect; from the *great extra friction* it occasions, owing to the number of angles the air is obliged to make, and the way in which it becomes, as it were, wire-drawn, in consequence of it, in its passage to the pumps. The effect of these counteractives, with that of the velocity with which the air rushes through the valve apertures, (many times greater than that at which it moves in the tunnel), is such as to render the pressure on the pumps several times greater than what takes place against the carriage; the degree of exhaustion requisite to move the carriage at the time the Committee were riding in it, being scarcely enough to affect even a spirit guage (much less a mercurial one) while in this supplementary pipe, a guage was altered several tenths.[1]

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[1] When the members of the Committee experienced the operation of the apparatus, one of them brought with him a mountain barometer, that he might ascertain the degree of "vacuum" or exhaustion necessary to move the carriage. This barometer was accordingly suspend-in the part where the "vacuum" was to be produced, and the vernier adjusted with the greatest accuracy. But to his surprise the degree of exhaustion was not sufficient to lower the barometer. Being aware of this, I had spirit guages previously prepared, one of which was fixed in the end of the carriage. But even this guage, though nearly fifteen times more sensitive than a mercurial guage, was (permanently) affected hardly enough to be visible. Yet with this circumstance, stated to you by myself, and with Sir William Couling's report, saying "the degree of exhaustion necessary to move a carriage, not being much more than the ten thousandth part of a vacuum : a diminution of density which would not lower the barometer so much as the two hundredth part of an inch,"—with these things before you do you say the power necessary is "somewhat about 100lbs. to move half a ton;" *ten times more* than is actually required to move that weight.

You observe "by contemplating grand objects our ideas enlarge with them ; and I now write of 100 tons, 1000 horse power, and 100 miles per hour, as familiarly and as readily as Mr. Vallance himself." Now, though not positive on the circumstance, yet do I suspect whether the converse of this position may not also obtain ; the degree to which it has been forced on me to rectify and explain about a "vacuum" having given rise to a surmise whether any thing short of a pre-existing and (judging from appearances, it might be supposed) perfect "vacuum" in the pericranium of the critic, could have led to such mistakes on the subject he criticises.

Never therefore was any one more unfortunate as relates to accuracy of investigation than you are in saying "this tunnel, with no extra friction," the case being, not only that the first mover has, in proportion to its power, a hundred times more friction to overcome, as relates to the machinery and air-pumps, than would take place in practice; but also than even this clog is added to by a manifold greater exhaustion than is necessary to move the carriage. Yet, notwithstanding all these impediments, does a little engine, which is, in appearance, only a working model on a large scale, (the purpose, by the way, for which it was made), prove the principle, by moving the carriage with six or eight people in it. And with all this do you exclaim "He cannot plead it is in a faulty state, nor can he expect on a larger scale to make it as perfect as this. Here, as in the case of all models, all ordinary obstacles are kept out of the way; and yet, from the operation of this, have a committee pronounced an opinion of its practicability."

"Wiser in his own conceit, than seven men who can each render a reason," is said of a class of character it is not necessary further to particularize; and as the reason rendered on the part of the seven gentlemen nominated to report on my "working model" was, that "your committee have inspected Mr. Vallance's apparatus for the conveyance of passengers and goods by atmospheric pressure, and can bear testimony to the success of it; having been repeatedly conveyed through the cylinder laid down by that gentlemen in Devonshire-place," it cannot be denied that they spoke from the evidence of their senses, and reported on what they had seen and experienced.

But instead of imitating their caution, and examining prior to condemnation, you, assuming an infallibility of judgment in no wise surpassed by the Holy Father himself, fulminate your anathema with a precipitation which is indeed pitiable; and not content with consigning me to the "limbo of fools," inform the public (with a self-complacency, on which I venture to offer my congratulations), not only that the gentleman to whom your letter is addressed, "was not very well acquainted with the subject," and that he acted as a first rate counsellor in pleading "the merits of a cause of which he knew little or nothing;" but also do you censure the committee for pronouncing at all upon it; although they express only a very qualified opinion upon what they have seen and experienced. Nor did they even venture to do this, until the conviction it produced had been confirmed by the written opinions of some of the most competent persons of the age being laid before them, concurring in the practicability of the measure to the fullest extent; and though, the restriction under which the most distinguished of these authorities favoured me with his calculations on the subject, deprived me of the benefits which would have resulted from being allowed publicly to state the result of the investigation he went into, still do you insinuate a charge of irregularity on the part of the committee for having alluded to the fact without declaring the name of the individual, notwithstanding the name had been declared by a personal friend of this authority at one of the public meetings, and that you had also been apprised of it by myself.[1]

In addition to this, and with a prescience that will immortalize, do you hold the inhabitants up as the laughing stock of all other towns, for having countenanced a scheme "the most impracticable that was ever undertaken." The degree to which this may raise you in public estimation, I take not on myself to decide; observing only, that if the profundity of your powers of computation entitle you to an exalted post in the Exchequer of Barataria, your powers of logic merit at least the Professor's chair in the university of that island.

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[1] Though I am not permitted to name the higher of these authorities, I have it in my power to quote the words of another. In a letter which Sir William Couling favoured me with (subsequently to his inspection of the Stockton and Darlington railway), he says, "Having been selected by His Imperial Majesty, the late Emperor of Russia, to examine and report upon all the Inland communications in this Empire, and having travelled for that purpose since July, 1824, nearly 12,000 miles, I trust I may be allowed, without presuming too much, to consider myself in some degree qualified to support your principle as far, very far superior to any other that I have seen, heard, or read of."

"If a man gives a false estimate of a person's character, he is accountable for all the losses which may be incurred by his having so misled opinion; and if the law cannot reach an individual or a meeting for bearing the same testimony to an invention, by which people may be influenced to risk, and afterwards to lose their property, the same moral wrong is done—if they do not render themselves liable for their losses, they may justly incur their reproaches, and no one can say undeservedly." These are your own words. On them I have to comment.

Without being just enough to take the trouble of examining whether the opinions you held were correct, you have done me gross moral wrong; and though, as you say, the law cannot reach you for it, yet so satisfied am I as to justice being done by the public, that I quote your own words to Dr. Yates in reply; and, in reference to myself, observe, I do "not feel myself the least humiliated." But as regards the public the case is materially different.

"As long absence," observes the historian of America, "had not extinguished the affection which Columbus bore to his native country, he wished that it should reap the fruits of his labour and invention. With this view, he laid his scheme before the Senate of Genoa, and making his country the first tender of his services, offered to sail under the banners of the Republic, in quest of the new regions which he expected to discover. But they could form no just idea of the principles on which he founded his hopes of success—they inconsiderately rejected his proposal as the dream of a chimerical project, and lost for ever the opportunity of restoring their Commonwealth to its ancient splendour."

Now similar to what the state of Genoa owed to those citizens by whom Columbus's proposal was despised and rejected, are your deserts from your country, so far as the will is equally criminal as the deed. To the utmost of your power have you decried a principle, which if proved correct, and rendered practicable, will be much more beneficial, as to the future welfare of our country, than all the gold and silver of Mexico and Peru would have been to Genoa.

It was usual with our opposite neighbours thirty years since, to deem that such or such a man "had deserved well of his country." Whether you are thus deserving, the following comparison may perhaps assist to decide. An individual is led to believe that there is necessary only a peculiar combination of well known machinery we have the means of making to any extent, to possess us of an advantage that will prove nationally important. With a devotion that may be unwise, but cannot be unworthy, he sacrifices his time and fortune to it. After "years, long, though not *very* many," he succeeds in demonstrating his proposition; both theoretically and on the scale of practice. The effect this produces, causes a gentleman to whom the circumstances of the case are made known, to say, "If you can obtain the public guarantee of the town of Brighton, that you have your principle in actual operation there, on a scale capable of carrying *persons* as well as goods, so as to secure me from any charge of attempting to mislead my friends; and a public expression of the opinion of the town in favor of the measure, as relates to an application of it between Brighton and Shoreham, I will undertake to get capital found toput it in practice there; but without a guarantee of this kind, which should most markedly distinguish this proposition from the late nefarious bubble companies of the Stock Exchange, I cannot attempt it; though, if this guarantee be obtained, I am confident I can raise the money among my connections." This proposition is agreed to; and the individual to whom it is proposed, comes to Brighton and solicits certain gentlemen to favor him by experiencing the operation of his apparatus, and then taking such steps, as the effect of it shall dispose them to adopt. They accordingly meet for the purpose; when the effect of what they experience is sufficient to induce them to sign a circular addressed to many of the inhabitants of Brighton, requesting them to meet on the subject[1].

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[1] Brighton, May 5, 1827.

SIR,—The undersigned having witnessed the Operation of Mr. Vallance's Principle for Transmitting Persons and Goods, by Atmospheric Pressure, and believing (if what we have seen on a scale of Yards can be extended to Miles) that it may be rendered very advantageous to the Town of Brighton, beg to solicit your attendance on Saturday, 12th of May, at the Old Ship, at 3 o'clock.

T. R. KEMP,
PHILIP L. STORY,
DAVID SCOTT,
THOMAS YATES, M.D.
JOHN LAWRENCE,
WM. KING, M.D.
JOHN LASHMAR,
H. M. WAGNER,
J. S. M. ANDERSON,
JOHN GLAISYER,
ISAAC BASS.

In consequence of this a meeting took place, at which a Committee was nominated to inspect and report upon the subject; and the parties then adjourned for a week to give time for examination. At this adjourned Meeting you appeared, and owing to the accident of being there something prior to the hour of attendance, a private conversation took place between the member of the committee who was appointed to give in the report, yourself, and the originator of the subject to be reported on; by the former of whom you are told, on giving him to understand you came to *oppose*, that the meeting about to assemble would consist of persons friendly to the measure, to consider how best to bring it publicly forward, and consequently that it was not the proper place to oppose it; opportunity for which would be given when it was brought publicly forward. But as there was no wish to smuggle the subject through, both this gentleman, and the originator of the proposition, requested you would attend the meeting; and oppose or approve, as you thought best. You accordingly did attend, and spoke against it. But your opposition being solitary, the course recommended by the committee,—that of signing a requisition to the High Constable, " to convene a Town meeting to take into consideration the best means of furthering so important an object," was agreed to, and a requisition signed accordingly by every person in the room.

The moment the business of the meeting was concluded, you rose to leave the room; when the originator of the proposition (whom the chairman had not permitted to reply to your opposition), personally requested you would witness the operation of his tunnel; but you declined it; leaving him, however, to understand, you would do so, before the public meeting took place. But you did not; and he not being one of those of whom it is said that "sufferance is the badge of all our tribe," nor disposed to

"Bend low and in a bondsman's key
With 'bated breath, and whispering humbleness"

solicit your charitable construction, the town meeting took place without your having done him the justice of examining what you made your appearance there to condemn and oppose. The result of that opposition it is no farther necessary to advert to than to state, it led you to write against the proposition; as a measure, the impossibility of which, was equalled only by its absurdity.

Now whether you have been right in doing this, time will shew. Should it prove you *were* right, it will be excused, that your conclusions are not according to the facts of the case; and you will be applauded as one who decided justly, notwithstanding that he reasoned incorrectly. But if on the contrary, the proposition you have so positively condemned, and the public trial of which you have attempted to prevent, should prove to be what the report sanctioned and adopted by the public meeting states it may, in the opinion of the committee, be, i.e., "attended with important advantages to this great mercantile nation," then will it be seen that the degree in which you have deserved well of your country, may possibly rise little higher than that which marks the merit of those citizens of Genoa by whom Columbus was treated as a "chimerical projector."[1]

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[1] "To think highly of ourselves in comparison with others; to assume by our own authority that precedence which none is willing to grant, must (says Hawkesworth) be always invidious and offensive. But to rate our powers high in proportion to *things*, and imagine ourselves equal to great undertakings, while we leave others in possession of the same abilities, cannot with equal justice provoke censure." I trust, therefore, it will not be imputed to me, that in adverting to Columbus, I presume to insinuate any parallel between myself and him; all that I mean being, that as he felt himself equal to "*things*," before unattempted in navigation, so do I not despair of effecting improvements with respect to "*things*," as relates to the facilitation of intercourse. In comparison with others I know my inferiority; but with regard to "*things*," I trust it

Hamlet is made to say,

> "Our indiscretions oft'times serve us well
> When our deep plots do fail; and that should teach us
> There's a divinity that shapes our ends,
> Rough hew them how we will!"

Owing to an incapability at which I was so annoyed, that I could have "divided myself and gone to buffets," I was unable so to reply to you at the public meeting, as to put you down in the way the weakness of your arguments would have admitted, by any one who was used to public speaking. Fortunately, however, for me, the apparent triumph which my weakness as an advocate permitted you to obtain, has induced you to print as well as proclaim your sentiments; and I have, in consequence, the opportunity of *writing* that which I ought to have spoken: and though my diction is equally weak as was my attempt at public speaking, yet, as the strength of my case will make up for my weakness as a writer, I appeal publicly against your decision, without other fear as relates to the cause I attempt

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will not be deemed presumptuous to have such faith in the superiority of mind over matter, as causes me to feel confident that all the difficulties of execution incident to what I propose, need only to be attacked, to prove equally superable as art and industry have rendered those which first opposed our passage across the trackless deep.

to advocate, than is confined to the degree in which it will suffer from my inefficiency.

In concluding, it may be expedient to compare turnpike roads, railways, canals, and the method of pneumatic transmission I propose. Turnpike roads are lines of communication, on which our persons may be conveyed at the rate of ten miles an hour, for an expense of about five shillings per ton per mile; and on which Tredgold states "sixteen and a-half farthings per ton per mile, for expense of power and attendance," must be charged for the conveyance of goods; since on a turnpike road "the greatest useful effect will not average more than three-fourths of a ton drawn eighteen miles by one horse in a day, or 13. 5 tons drawn one mile."

At page 363 of the Quarterly Review for March, 1825, it is said, "we have also a list of rail roads, (some tram-rails, others edge-rails; some of *cast*, and others of *wrought* iron) containing upwards of five hundred miles; and the general average, allowing them a double set of tracks, is, as near as possible, four thousand pounds per mile; but from the imperfections of these old roads, we may extend the average to five thousand pounds per mile;" and as Tredgold says, "the average cost of a proper rail road, with a double set of tracks, will not be less than five thousand pounds per mile," we may take it at that sum. But with reference to railways which are to answer the purpose of turnpike roads, the case is widely different. In the first prospectus of the Liverpool and Manchester railway, the estimate for the thirty miles it mentions is £510,000, or £17,000, per mile. In a second prospectus, published a year after, this estimate was raised to six hundred and thirty-five thousand pounds.[1] The expense of horse power only, on a level rail road, Tredgold states to be a half-penny per ton per mile; and the day's work of a horse equal to one hundred and eight tons, drawn one mile.

The expense of steam power (locomotive engines) vehicles and attendance, Tredgold estimates at about a half-penny per ton per mile, when going at the rate of six miles an hour, which he adverts to as an extreme velocity.

The Quarterly Review for March, 1825, says, "we have before us a list of the estimates for no less than seventy-five canals, including those of the greatest and those of the least expense, and the general average is seven thousand nine hundred and forty-six pounds per mile; and as the estimated expense is generally very much exceeded, we may fairly set down the real cost as nine thousand pounds per mile." Tredgold says the average cost of a canal may be estimated at ten thousand pounds per mile; and adverting to an estimate for the Liverpool and Manchester rail road (twelve thousand pounds per mile), the Quarterly Review says, "the Union canal is stated to have cost just as much; the Forth and Clyde twice as much; the Regent's canal, we are afraid to say, how many times as much; and the Caledonian more than four times as much."

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[1] I quote this sum from memory, not having the document before me.

The day's work of a horse on a canal, Tredgold states to be "about twenty-two tons drawn twenty-three miles; or five hundred and six tons drawn one mile; which is about half a farthing per ton per mile, for power, without including additional attendance, or wear and tear, and expense of boats."

Owing to the proportion which the expense of the steam-engines, air-pumps, machinery, and other necessary works at each end, will bear to the expense of the line of tunnel, the principle I propose could not, on so *short* a line as between Brighton and Shoreham, be rendered effective for much less than £75,000: which, per mile, would be nearly as much as the Liverpool and Manchester railway will cost. But on such a line as from London to Brighton, it *might* be done for £10,000 per mile. Calculating that the force of traction "is inversely proportional to the diameter of the wheels," the expense of power to move goods in the tunnel would be *less* than "the twenty-fifth part of a farthing, per ton, per mile:" not one-tenth what it would be on canals; nor one twentieth what it would be on rail roads by locomotive engines; while in comparison with coach conveyance on turnpike roads, it would be hundreds of times cheaper, independent, both of the saving in time, and of being secure from the whole of the accidents to which road travelling is liable: it being alike impossible either to be overturned, run away with, driven against any other carriage, or obstruction of any kind, or to break down so as to experience any injurious concussion or accident.

The whole of these advantages, however, important as they are, dwindle into indifference when contrasted with the saving in time. "Ask me for any thing else," was the reply of Buonaparte to his Generals, when they desired time. "The element of which all things are composed," was another of his expressions relative to time; and though the simile may be more figurative than accurate, yet is it highly expressive of the value of time in reference to the acts of man.

The tunnel I have, will admit of exhaustion to a degree that would give several inches of mercury: and should one be laid down to Shoreham, I will pledge my credit on its bearing a proportion of vacuum that should lower the barometer twice as much: while, were we to make a tunnel of cast iron—which we most assuredly could do, if we chose—a proportion of vacuum might be obtained which should give *many* inches of mercury. I have been favoured with calculations by two of the highest scientific authorities of the day (independent of Sir William Couling's) which shew that a degree of exhaustion equal to the support of only one inch of mercury, would give a velocity of above one hundred miles an hour: and from the result of many observations made by Rouse, Borda, Valz, Beaufoy, and others, to judge of the rates at which winds blow, as determined by instruments to measure their force and velocity, we have reason to feel satisfied that practice will bear out theory in this particular. Now if it does, who can assign a limit to the rate at which we may cause ourselves to be conveyed, when practice shall (as in the case of the *ice boats*

De Roos mentions) have given us the experience necessary to " manage" the vehicles in the tunnel, under velocities such as the mind is involuntarily led to contemplate in connection with the proposition.

After shewing that respiration would not be at all affected by any velocity at which we might be conveyed, I observe that, " the only limit we shall experience in point of velocity, will be that which the wheels of our vehicles will bear," and that " at whatever rate we can make wheels revolve on their axes, we certainly may cause ourselves to be conveyed." Commenting on this, Sir William Couling observes, " at whatever rate air can be pumped out of the cylinder, the vehicle will be carried forward, provided that velocity does not exceed the rate at which wheels can revolve on their axles without ignition: with reference to which it is to be observed, that the number of revolutions made by a carriage-wheel, depends on the size of that wheel, as well as on the motion of the vehicle. The fore-wheels of the coaches which travel with the greatest expedition, revolve, on an average about 100 times in a minute. One of the peculiar advantages of the method Mr. Vallance proposes is, that it admits of the wheels of the vehicles which move in the cylinder being several times larger than the wheels of carriages which run on roads; that is, from ten to twelve feet in diameter, or nearly four times as large as the fore-wheels of a coach. The same number of revolutions, therefore, which the fore-wheel of a coach makes in an hour, would move the vehicle in the cylinder forty miles; and twice and a half that number of revolutions would give 100 miles an hour. Now if a common coach-wheel, which moves under the disadvantages of being constantly exposed to all the clogging and impediments arising from the dust and dirt of the road, can revolve for hours together at the rate of 100 times a minute, without being greased, excepting at the end of its journey of perhaps 100 miles, it may fairly be presumed, that a wheel, which would be free not only from all dust and dirt, but also moving in a reservoir of oil, would revolve 250 times in a minute without heating, even had we no such evidence as that referred to in page 36; but when that is taken into consideration, all anxiety with reference to the effect a velocity of 100 miles an hour would have on the axes of the wheels, may be dismissed." Now if exhaustion to a degree that shall support an inch of mercury, will give us a motive force of above 100 miles an hour, and if wheels will revolve so fast without firing, we may feel confident that it will be possible to save *at least* half the time it now takes us to get from one place to another: while we have every reason to believe that the actual saving will be very much more than half. Half, however, will be enough to calculate on.

In the debates on the Act for limiting the number of passengers a stage coach should carry, it was said, that there are daily 10,000 persons travelling by stage coaches in England. Now assuming the practicability of this method of pneumatic conveyance—carrying our views a few years forward—and supposing 10,000 people to have half a day saved 312 times a year, the aggregate saving would amount to 1,560,000 days labour for one man; or 156 days for 10,000 men; and though the labour of those who travel by stage coaches, is not of that productive kind which would render this view of it correct as regards effect, still would the saving be far from unimportant, even to the nation; and as half is by no means the limit to which time might be economised, while expence would also be reduced in a corresponding proportion, it may very justly be said, that the principle holds out advantages which we can no more estimate, than Smeaton, when he doubted that the steam engine "would never be generally introduced" could suppose, it would one day be said of it, that it "had fought the battles of Europe against the French Revolution." So far therefore from doing as you recommend, that is, attempting *no more*, because only a *little* has yet been done, we have every reason to "go on" and expect to "prosper."

The theory is denied by no one. Its practicability is proved on a scale that carries conviction to the mind of every one who has seen it except yourself; and as I am not aware that deeming myself equal to the completion of this "thing" while pages 44 and 86 of my pamphlet[1] prove that I "leave others in possession of the same abilities," renders me liable to censure, I conclude my observations with this remark: that you pronounce it *im*possible, because you feel that to *you* it would be so; while I pronounce it possible, because I know all that is wanting to render us equal to the execution of every particular is, to bestow on the subject the same degree of attention which Watt gave to the steam engine, Arkwright to the cotton machinery, Brindsley to canals, the neglected Winsor to the gas light principle, or the equally neglected originator of of steam navigation to steam vessels, &c. I therefore urge its application to the conveyance of goods between Brighton and Shoreham, because, in rendering it matter of profit there, we may also render it matter of instruction as to those points relative to the conveyance of our persons—the velocity beyond which it will be unpleasant, as well as unsafe, to suffer ourselves to be carried, &c. &c. &c. which only the experience gained from actual practice, can inform us upon.

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[1] "It was the remark of one who well knew human nature that 'when the mind of man has once conceived a great idea, it can scarcely be relinquished: it broods over that idea continually; and one difficulty being at length surmounted, affords encouragement to go on, in hopes that others may in like manner be overcome.' It will be admitted, that the faculties of Englishmen are equally comprehensive, and their minds to the full as aspiring, as those of their fellow-men; and if it be also admitted, that the idea it has here (most feebly it is true) been attempted to convey to them is worthy of their attention, there is little doubt but that the fifth revolution in our means of intercourse will be effected in a period very much shorter than that which has elapsed between the establishment of canals, and the laying down rail-ways. While revolved upon by a single mind, it might well, like a flower from which the genial rays of the fountain of vegetable life were withheld by obscuring clouds, exist only as a bud. But let the clouds be removed, and the fostering influence of the public intellect

In closing my letter, it may be permitted me to make use, first, of a string of interrogatories put by a public character of high

beam full upon it, and short indeed will be the period which shall intervene, ere it fructifies, and expands into a mean of the highest national importance."—P. 44.

attainments ; and 2dly, of matter I have made private use of before. It has been, and will, doubtless, again be, objected by many, that it must be "impossible" that what I propose should succeed ; because, not having been educated, and bred up to such pursuits, I cannot know anything about them. Had Telford, or Rennie, or Brunel, or any other first-rate man, originated the proposition, then, indeed, they might have had some faith in it!

But for an unknown nobody to do such a thing, is of itself enough to prove that it *cannot* be worth attention. To casuists of this kind I would reply, by asking them—to whom are we indebted for the steam engine in its application to steam vessels, and locomotive purposes, as well as a first mover for machinery? Savary, its first inventor, was a miner. Newcomen and Beighton, its first improvers, were, one of them a country blacksmith, and the other a plumber. To whom are we indebted for our canals—for our nationally important cotton machinery—for the public application of the gas-light principle—for the system of rail-way transmission — for the hydrostatic press —and the other manifold improvements, which have raised us to the station we fill ? Is it to men, who, at the times these improvements were first devised, were of high name, and established reputation? Hear what one whose situation enables him to decide, says on the subject:—

"What has been the means of raising our native country to that eminence in civilization, which renders her the admiration of the world? Her improvements in the arts and sciences. From whom have those improvements chiefly sprung? From men who have emerged from the humbler walks of life. What was Sir Richard Arkwright; a man to whose genius this country is indebted for very much of its commercial prosperity; to whose improvements in the machinery for spinning cotton, we are indebted for being enabled to keep the cotton trade chiefly confined to ourselves. What, I say, was the great Arkwright? A barber. Yet do we owe our proud superiority in this department of our national greatness to the unassisted efforts of Dick the barber.

"Who was Ferguson? A simple peasant; a man, who, wrapped in his plaid, passed the winter nights on the ground in contemplating the Heavens; and who, by arranging his string of beads on the cold heath, at length completed a map of the stars, and raised himself to the knowledge of our late Sovereign.

"Who was Dr. Herschel, the discoverer of so many important astronomical facts? A boy who played the pipe and tabor in a foreign regimental band. Who was the great Watt? A mathematical instrument maker.

"Who was Smeaton, the builder of the Eddystone lighthouse, and the first engineer of his day? An attorney.

"Who was the great Brindsley, whose canals have given such an accession of power to our commerce, by the facilities of internal communication? A country millwright.

"Nicholson was a cabin boy: and Ramadge, the best maker of reflecting telescopes in the world, was a cutler."

With these instances, that individuals who were not educated for, nor regularly brought up to such purposes, have originated improvements that have proved nationally important, ought a proposition to be condemned, merely because it is made by one whose station is as humble, as his name is unknown?

"The question is not 'Can we construct, lay down, and connect, cylinders of the requisite size, so as to render them effective to the purpose contemplated;' for our experience in casting and working iron renders that a certainty, *provided we choose to be at the expense of it.* Nor is it, 'Can we construct air-pumps of sufficient size, to exhaust from this cylinder with the necessary rapidity,' for that has long been done; and it needs but multiplying that instance, to give us whatever we may require in this particular. Neither is it 'Can we construct a vehicle capable of moving along in the cylinder;' for every one must see that is practicable. But it is 'Can we construct the cylinder of the cheap material clay, instead of the expensive material iron?

"This is the real question; and in venturing to reply affirmatively to it, a consideration or two, deprecative of the censure such presumption must incur, may be urged.

"It has been the lot of too many to find, that in venturing to say to the world 'this, or that thing, which you conceive impossible, I can accomplish,' they have caused those who before perhaps deemed them only fools, to look upon them as knaves. Were it not, that the doing it might be misconstrued into daring to conceive a similarity between those illustrious persons, and the unknown individual who refers to them, the cases of Columbus, Galileo, and even Newton, might be adduced in this particular.

"When, nearly a century ago, Jonathan Hulls proposed the application of steam to navigation, what less than a fool was he considered, notwithstanding that we, who see it both propel vessels, and draw loads, which in those days it was indeed 'impossible' to move, know that his proposition resulted from the superiority, instead of the inferiority of his intellect? Arkwright, for presuming to think he could better himself, by giving his attention to the improvement of the cotton machinery, instead of continuing to scrape chins, was all but deemed, by those whose *superior wisdom* saw the *absurdity* of his so doing, a fit subject for a straight waistcoat. The contempt, vilification, and caricaturing with which the gas-light principle was first met, we all know. And in venturing to say, that notwithstanding it may to others appear impossible, he who writes this is prepared to construct cylinders of burnt clay, (not brick) which shall be both air-tight and equal to every requisite of the case—in venturing to say this, he expects no other, than that the declaration will also be met with exclamations of 'impossible' and 'absurd.'

"With respect to the multitude, these things will be but little regarded. But as even among those, whose practice and attainments ought to enable them to see reason to act differently, there may be some, who will join and greatly strengthen this cry, it may be well to advert to two cases, in which those of the greatest practical experience were so wrong, that, had their opinions been allowed to operate, we might have been at the bottom of the list of nations, instead of standing where we do.

"At the meeting held to consider the propriety of erecting a monument to the late James Watt, it was stated by the son of the gentleman to whose co-operation Watt owed his success in business, that 'At the period of the construction of the first steam engine upon his principle, at Soho, the intelligent and judicious Smeaton, who had been invited to satisfy himself of the superior performance of the engine by his own experiments upon it, and had been convinced of its great superiority over Newcomen's, *doubted the practicability of getting the different parts executed with the requisite precision, and augured, from the extreme difficulty of attaining this desideratum, that this powerful machine, in its improved form, would never be generally introduced.* Such was, at that period, the low state of the mechanic arts, as fully to justify his opinion; but a school of workmen in every relevant branch was speedily and successfully instituted, and the forms and construction of the machine, were perfected with a skill and accuracy till then unknown in the execution of large machinery."

"But this is not all. In Philip's History of Inland Navigation, it is stated, that when the first canal cut in England "was completed as far as Barton, where the Irwell is navigable for large vessels, Mr. Brindsley proposed to carry it over that river, by an aqueduct, thirty-nine feet above the surface of the water in the river. This, however, being considered as a wild and extravagant project, he desired, in order to justify his opinion towards his noble employer, that the opinion of another engineer might be taken, *believing that he could easily convince an intelligent person of the practicability of the design.* An engineer of eminence was accordingly called, who, being conducted to the place where it was intended that the aqueduct should be made, ridiculed the attempt; and when the height and dimensions were communicated to him, he exclaimed, 'I have often heard of castles in the air, but never was shewn before where any of them were to be erected.' This unfavourable verdict did not deter the Duke from following the opinion of his own engineer. The aqueduct was immediately begun, and it was carried on with such rapidity and success, as astonished all those who, but a little before, thought it impossible; and within twelve months did the crews of the vessels navigating the Irwell, see the Duke's barges sailing over their heads, in the channel upborne by this 'castle in the air.'"

"Now had it happened that, because these engineers, who were both (more particularly Smeaton) men of great eminence, did not see how the difficulties incident to the respective cases could be overcome, those who supported Watt and Brindsley in their attempts, had withdrawn that support, because great names pronounced the objects they were aiming at "impossible,"—had this happened, could the President of the Board of Trade have had to say, "But I cannot help stating, that on looking back to the contest in which we were for the last quarter of a century engaged, it is not too much to say that we are mainly indebted to the new resources furnished us by Mr. Watt, for the manner in which we brought that contest to a conclusion; or the First Lord of the Treasury been commanded by his Majesty to state, "That he feels deeply sensible of the merits conferred on this country, by the individual to whose memory we are now about to pay a tribute of respect and gratitude; and that his Majesty is most anxious to place his royal name at the head of the proposed subscription, for the sum of £500."

"And yet is there nothing one whit more difficult than (nor indeed so difficult as) what Brindsley and Watt accomplished, in the object here proposed. But even though there were, would that be any reason to despair of effecting it? There are others, beside him on whom has devolved the duty of advocating it, who see it practicable. And is it to be supposed, that their perceptions are more acute than those of their countrymen? They but too deeply feel the contrary; well knowing, that if public attention could but be so turned to it, as to cause our men of science to give it consideration, difficulties would disappear as fogs from before the sun."

The proportion in which future times shall acknowledge that the sun of your intellect contributed to disperse the clouds by which public perception on the subject is at present obscured, I leave to yourself to decide.

I am, Sir,
Your most obedient Servant,
JOHN VALLANCE.

APPENDIX.

It may be as well to take advantage of the necessity which has been imposed on me, of rectifying mis-statements of one sort, to rectify those of another description. For purposes of the basest kind, a well known character has chosen to charge me with pirating an idea broached some fifteen years ago, by a Mr. Medhurst. To set this question at rest, it will be only necessary to shew the difference between the two propositions.

It appears, that in the year 1812, Mr. Medhurst published a tract, recommending the transmission of persons and goods through a square tube, by air forced into the tube as from a pair of bellows, i. e. by a *plenum*; instead of by exhaustion or "*vacuum.*" To this tract he put his name as "*Patentee,*" notwithstanding that the records of the Court of Chancery prove he never had any patent for it.

When I first took up the investigation, I knew not that it had ever been thought upon by any one: and the way in which the idea first presented itself to me, was to operate by a plenum; and force air in behind the vehicle, as from bellows. But on entering into the calculations which became necessary, as soon as I had ascertained we had the means of rendering the principle practicable so far as related to the construction of the tunnel, the air pumps, and steam-engines to work them, I found that the friction of the air, would absorb power to a degree that would render this method of operation utterly impracticable.

In consequence of this, I turned my thoughts to operating by a "vacuum," instead of a "plenum;" and to rendering the atmosphere the motive force, by exhausting *from* the tube instead of pumping *into* it; and as it was evident, that by arranging valves at every mile, or half mile, as experience directed, which the vehicle should open as it passed over them, air might be admitted where we pleased, and the

1825 — Patent
they in 1827

moving power, as it were, renewed as often as should be necessary, instead of operating only from the end; while the effect of exhaustion was to *diminish* instead of increase friction; as these things were evident, I was careful, both in my patent and my pamphlet, to disclaim any exclusive right to the method of operating by a plenum; or blowing air in behind the carriage. Mr. Medhurst has, therefore, the claim of originality of invention, to whatever benefit may result from operating by a plenum, or moving a vehicle in a tunnel, by air pumped in behind it; as I not only disclaim the process, but also *pro*claim that it will not do.

But these are not the only distinctions between my proposition and that of Mr. Medhurst: the "arrangement without which the operation of the principle would even be attended with doubt, delay, and danger," that is, "the new mode of telegraphic communication, described in the last section of the treatise; which, being equally efficient during the most foggy weather and darkness, as in day-light and clear weather, will admit of instantaneous communication between those who direct operations at each end; so that any thing it may be necessary should be known at one end, may be instantaneously communicated from the other, independent of the method of conveyance itself," being a third distinguishing feature.

Blind, however, to all these things,[1] the notorious dealer in falsehood and calumny to whom I have alluded, but whose name shall not sully the page, has had the audacity to charge me, by statements in the public papers, and various prospectuses (which I hold, and shall produce as evidence in the action I have been advised to commence against him) with pirating the idea, first from himself, and then, when he found that ground untenable to a degree which induced even him to abandon it, from Mr. Medhurst. It became necessary, therefore, to point out the distinction between the two propositions; and having done that, I will advert to the circumstances, which cause me to say, that whatever benefit may arise from operating by a plenum, Mr. Medhurst will deserve the credit of it.

"The rate at which a fluid will rush along a pipe, depends on the pressure operating upon the fluid, and its friction against the pipe. The friction of a fluid against a pipe, increases with the length of that pipe. Let the velocity with which a fluid would rush along the part of the pipe it first entered, be what it might, provided the pipe were long enough, friction would increase sufficiently to reduce this velocity to almost nothing. A circumstance which occurred some years ago, is conclusive on this particular. It is too well known, to be at all affected in point of veracity, by an inability to mention either the exact time or place, that the proprietor of an iron work in Wales, had, some years ago, occasion to erect an additional furnace at the distance (recollection states) of about three-quarters of a mile from his old ones. The blast apparatus of these old works being large enough to supply this new furnace in addition to the old ones, he conceived it would prove much cheaper, if, instead of having power and blast cylinders erected at the new work, he were to lay a pipe from the old ones, to convey to the new one the superfluous blast. This he accordingly did; and as soon as the pipe was completed, set the apparatus going, to ascertain the strength of the blast he could thus apply to the new furnace. To his great surprise, however, no blast was produced; a gentle current, which would not blow a candle out, being all that was perceptible. For a result so adverse to his expectation, he could account in no way, but by supposing that from accident or design, the pipe was stopped up. As the readiest way to ascertain whether it was so, he put a cat in at one end, and blocked it up, leaving her to find her way to the other.

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[1] Page 34 of a certain Letter to Dr. Yates shews, however, that there is one other person at least equally blind.

Eagle
Foun
Pape

"The pipe, though large enough to allow her to move forward, not admitting of her turning round, puss had no alternative but that of seeking an exit at the other end: this she accordingly did, and, contrary to his expectations, soon made her appearance there. Convinced by this, that there was no obstruction in the pipe, he concluded, that the disappointment he had experienced arose from the friction of the air against it; and finding that he could in no way obviate this difficulty, he was obliged to throw the pipe aside, and be at the additional expense of blast apparatus for his new furnace.

"Now, had the proposition this treatise submits been, that we should convey ourselves through a cylinder such as has been adverted to, by employing apparatus on the principle of blast furnaces, to blow us through, by *forcing* air in behind us, the circumstance which has just been stated would be fatal to that proposition. But when, instead of being blown through, by air *forced* in behind us, it is proposed to cause the air which is behind the vehicle to operate to push it forward, in consequence of some being taken from before it, the case is widely different. Air which is forced to move in a pipe, in consequence of other air being driven into that pipe behind it, operates as a wedge, and opposes to the power which moves it, resistance arising from becoming, as it were, wedged against the pipe, through its whole length. But air which, instead of being *forced* to move by an impulse from behind, that wedges it against even the very end of the pipe it enters at, is *allowed* to move, owing to some being taken out from before it, instead of being forced in behind it, becomes affected, as any thing from which a wedge is *withdrawn* is affected; that is, freedom of motion is allowed, and its parts play so much more freely, that friction is diminished instead of increased. The impediment would prove, therefore, less important in this case than in the other, even were there no method of altogether obviating it; happily, however, the means of doing this are in our power. Between driving a vehicle through the proposed cylinder by forcing air in behind it, and according to the method which has been stated, there is this difference,—that in the former case the impulse can be given only from the end where the moving power operates; while, in the latter, arranging valves, which should be opened by the vehicle as it passed over them, would admit of that impulse being renewed at every hundred yards, could it be necessary to do it so frequently. Let the friction of the air against the pipe be what it may, therefore, a valve at every mile, or two miles, or five, or other number of miles, which (as may be done) should be opened by the vehicle as it passed along, and caused to remain open, till it (the vehicle) had arrived at the next valve, would prevent any diminution of the velocity at which we might be conveyed, that would prove important."

This reasoning may be illustrated by a figure relating to an experiment Mr. Medhurst mentions. Air was forced through a pipe 56 feet long, at the rate of 20 miles an hour; under a pressure which is equal to 2. 2 inches of water; and as he states previously, that it required a pressure which is equal to 0. 6 inches of water to make air move at that rate through a hole in the side of a vessel, there was consequently 1. 6 inches greater pressure at that end of the pipe at which the air entered, than at the end from whence it issued.

Now if the length of the pipe—the tenths of pressure at the entering—and those at the issuing end, be expressed by two lines approximating each other, as shewn in the margin, it may be conceived how "air which is forced to move in a pipe in consequence of other air being driven into that pipe behind it operates as a wedge; and opposes to the power which moves it, resistance, arising from becoming as it were wedged against the pipe, through its whole length."

Since the length of these two lines, bears the same proportion in hundredths of an inch to 56 feet, as the spaces between the ends of them bear (in tenths of an inch) to 2. 2. inches of water, and 0. 6 inches of water;[1] and if we conceive that forcing air to move in this way, is in some degree analogous to drawing an elastic, endless rope, the size of which should be equal to the larger end of the pipe, through it, and out at the smaller end, we may form some idea of the degree to which power would be absorbed in operating by a plenum. And not only this; since reversing the operation, and supposing the rope to be drawn from the smaller to the larger end, will also give us some idea of the effect of operating by exhaustion, or vacuum; and enable us to conceive that "air which is allowed to move, owing to some being taken out from before it, instead of being forced in behind it, becomes affected, as any thing from which a wedge is withdrawn, is affected; that is, freedom of motion is allowed, and its parts play so much more freely, that friction is diminished instead of increased."

And as every additional 56 feet (or doubling of its length) that might be added to any pipe through which air was forced as from bellows, would double the pressure, it may easily be conceived that increased friction would cause increased condensation, and increased condensation again increased friction, till the effect became realised which the proprietor of the iron works experienced.

From not being aware of this, the results Mr. Medhurst draws are erroneous to a degree which causes him to state that the density of the air would be increased only the 77th part; whereas it would be *doubled*; and owing to the pressure being eccentric instead of concentric, the tube, or "canal" he proposes, would be blown to pieces; while the power required would be fifty times greater than he states. It is true, that his error is increased by calculating according to the rule of *simple proportion*, after he has laid it down as an axiom that "in different degrees of velocity, the resistance by friction will be as the *square* of the velocity;" but the fatality pervades the foundation as well as the superstructure.

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Having thus cursorily adverted to the distinction between what I propose, and for which I have obtained a patent, and what Mr. Medhurst proposed in 1812 and stated himself to have a patent for, notwithstanding the records of the Court of Chancery prove such statement to be contrary to fact, I conclude by saying, that I knew not, until after my own patent was obtained, that the idea had ever been thought of by any one besides myself: though I have since learned, not only that Mr. Medhurst, but many others had *thought* of it; and I find the principle of transmitting power, or rather imparting an impulse by means of a vacuum produced by air pumps, to have been operated on by Papin nearly 150 years ago. My patent, however, being, not for the principle, but for the combination of the valves, telegraphic apparatus, &c. &c., is no more affected by this, than my judgment is by charges relative to non-originality of invention—since, in neither my patent nor my pamphlet, do I assert originality; though I believe myself to be the first who ever worked (or carried) the principle through, even in theory, independent of reducing it to practice.

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[1] The limits of the page render it necessary that the scale of length should be in hundredths of an inch, but as the width would have been imperceptible had the same scale been observed, tenths are adverted to for it.

EXTRACT

FROM

THE PAMPHLET ON RAIL-WAYS,

REFERRED TO IN PAGE 54.

It will eventually be seen, that there are, perhaps, none who more, or even *so highly*, uphold the *principle* on which transmission by rail-ways depends, as he who thus controverts the practicability, belief in which is the chief inducement to their being subscribed to. But the highest sense of the value of this principle, when properly applied, ought not to cause blindness relative to the impediments there are to any such increase of the rate at which we travel, as shall come up to the expectations the public have been caused to entertain relative to common rail-ways.

Overlooking the circumstances which constitute the real impediments to any such increase of velocity, it is assumed, that as we have the power of causing steam-engines to drive the wheels of *fixed* machinery at any rate we please, so have we the power of causing them to drive the wheels of locomotive machines at a similar rate; and that it needs but to connect the cranks of locomotive engines to the wheels on which they travel, by proper machinery, to enable us to double, triple, quadruple, quintuple, &c. &c., the rate at which those wheels revolve, and consequently the velocity with which the vehicle moves forward. A little investigation will, however, give us to perceive, that this opinion may prove erroneous.

The motion of any loco-motive machine which is driven by fluids, such as steam or air, acting on pistons, must depend, in the first instance, on the number of strokes those pistons make in a minute.

The strokes of all fixed steam-engines are limited to a certain number per minute; and cannot, without incurring the risk of the engine's tearing itself in pieces, be increased much beyond that number. If, therefore, there is a limit to the strokes, even of an engine, which, from being fixed, will admit of the utmost possible firmness being given to all the parts, how much greater must be the necessity of a limit to the number of the strokes of those which are locomotive? The rate beyond which it is ascertained the piston of a fixed engine *ought not to move*, is 220 feet per minute, 2½ miles an hour, that is; and if, to place the question in the most favourable light, we suppose that the pistons of loco-motive engines may, by methods yet to be discovered, be enabled to work properly when moving with twice that velocity, still will their rate fall vastly short of that at which we now travel. With reference to the first cause of motion in locomotive engines, there appears then an impediment to any velocity much exceeding five miles an hour.

But, it will be observed, the rate at which the vehicle moves depends, not on the velocity of the pistons, but on the size of the wheels, and the number of times the action of the pistons causes them to revolve per minute. Admitted; and thence may arise another difficulty. Theory and practice appear to prove that no locomotive engine ought to make above fifty strokes a minute. They also appear to prove, that the wheels on which loco-motive engines move, ought not to exceed 3.18 feet in diameter. Supposing both these extremes to be come up to, the motion will not equal six miles an hour. To increase it beyond that, one of three things must be done. Either the pistons must make more strokes per minute than is considered safe; or the wheels must be increased beyond the size which theory and practice combine to prove ought not to be exceeded; or intermediate gearing, to render the revolutions of the wheels more numerous than the strokes of the pistons, must be made use of.

By the first, the danger of accident to the machinery would be increased, in a proportion which would appear to put it out of the question. The impropriety of increasing the diameter of wheels, which are to carry from five to ten tons[1], at rates many times faster than the strongest carrier's waggons dare go with the same load, and which are not merely to equal, but also greatly exceed those at which the mails travel, would appear to reply decidedly in the negative to the second.

And though the third may, at the expence of part of the power of the engine, be effected, yet will doing it but bring additional opposing circumstances into consideration.

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[1] Some eight-horse locomotive engines are stated to weigh eight tons, others little more than five.

Against travelling with any velocity horses can draw us on common road, there is no impediment, owing to the wheels touching the road only on their peripheries, and being consequently free to vibrate or quiver, and trivially deflect from the exact right line, as is inseparable from the wheels of a vehicle in rapid motion.

But it is a question, whether the attrition which must unavoidably take place between the side of the wheels and the flanches of the rails, or the flanches on the wheels and the sides of the rails (as edge or flat rail-roads are used) will not oppose an insuperable impediment to any increase of velocity, greatly beyond that at which goods are now conveyed on rail-ways[1].

Another question to which it seems difficult satisfactorily to reply, is, " Can locomotive engines be *guided* with the requisite nicety, when moving at a rate much exceeding that at which they now travel ? On a common road, a vehicle can be guided under almost any velocity, owing to its being quite immaterial whether it moves in an exact right line, provided the line of the road is kept ; but on a road which will not admit of the slightest deviation from the right line, without danger of (what even now is no unusual occurrence) the wheels gathering upon, and running over the rails, it becomes an important question whether loco-motive engines can be guided with sufficient accuracy, to prevent imminent danger of being overturned, when going above six miles an hour? With horses, it certainly would not be safe to travel on railroads at any greater rate; for were they to start, or in any way deflect from the line they ought to follow, *over* the vehicle must inevitably go; and it is not seen how we could be secured from it, if drawn by locomotive engines. The windings, too inseparable from rail-ways, will so greatly increase the danger of accidents of this nature, that it may well be doubted, whether a velocity exceeding six miles an hour can, consistent with safety, be attained on them.

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[1] Mr. H. R. Palmer's treatise on Rail-ways, specifies some particulars relative to this and following considerations. " The power that gives the motion is necessarily at a great distance from some of the carriages, and if the line be irregular, the power will not be exerted in the direction of the motion of the carriages : *their motion will consequently be partly directed by the re-action of the flanches on the sides of the rails*, and the amount of that re-action is deducted from the effect which the power might otherwise produce ; and as much power as is equal to that re-action is exerted *to displace the position of the rails*. But it is not enough that the general arrangement of the line be as free as possible from bends ; if the parts themselves do not nicely correspond to it, a resistance is encountered which is not necessary in principle. Some arrangement is always necessary to preserve the direction of the carriage. On tram ways. the flanches on the plates serve that purpose ; on flat-edged rail-ways, flanches on the wheels are necessary ; *and the smallest imperfection in the rails will occasion a continual rubbing of the one against the other, making a resistance greater than that of the imperfection of surfaces ;* and every such action tends to disturb or loosen the rails, and the foundation on which they stand.

" In tram roads, the rims of the wheels are ganerally so far out of proportion to the strength of the materials, that, by successive motion, they form a rut or groove in the plates, and ultimately divide them longitudinally into two parts. The object of the small width is principally *to pass the obstructions lying upon the rails* the more easily. When any such irregularity is once found, the wheels, from other imperfections in the works, do not follow uninterruptedly the courses of those ruts, *but are frequently escaping upon the sides of them*, and, returning again, act with a violence on the rails, which tends to disturb their position, *and produce frequent fractures*."

Another question on the same subject is, "would it be proper to travel on them with a velocity exceeding six miles an hour, when it would be impossible to steer clear of any impediment, whether great or small, which accident might place in the track?" On a coach, a touch of the rein will enable us to clear any stone, *over* which it would be ill-judged to attempt forcing the wheel; and impediments of a more serious nature may be avoided by taking the other side of the road. But when moving in a track from which it is impossible to deviate, we cannot steer clear of any impediment which accident may interpose; and how far this will be consistent with safety, under a velocity at all considerable, need not be pointed out.

It should seem, therefore, that although intermediate gearing between the crank shaft, and the wheels on which the vehicle moves, will admit of locomotive engines being moved a greater space than their pistons pass through in an hour, yet that there are other impediments to a rate greater than six miles an hour being attained, which *appear* inconsistent with safety.

So far the theory of this part of the question. With reference to the practice, it is asked, "Is there any instance of a locomotive engine travelling—not twenty, nor fifteen, nor twelve—but ten, or even eight miles an hour, *regularly, and as a constant rate?*" It is replied, No, not one. Four and five miles an hour, it is known they do get over, and that too with enormous loads.

But there is no instance of any locomotive engine having (regularly, and as a constant rate) travelled faster than, if so fast as, six miles an hour.

It would appear then, that instead of the speed at which we can be conveyed by locomotive engines on rail roads, coming up to the greatest we can exist under, it will not exceed, if indeed it equals, that at which coaches convey us.

No one, therefore, who embarks capital in rail-ways can sit himself down with any assurance that the expedition which may be made on them will be what it shall prove impossible to exceed; and that such capital will be secure from a depreciation, similar to what is now taking place relative to canal property.

The condition next to be considered is, whether rail-ways give us the power of rendering our progress continuous and unremitting, from the commencement to the termination of the journey?

This condition needs no discussing as relates to horses; and from its being stated, that an eight-horse locomotive engine consumes nearly 2½ bushels of coals and 65 gallons of water, to convey 16½ tons about 4½ miles an hour, the question must be decided in the negative with reference to them.

The last condition is, transmission at the least possible expense: with reference to which it is to be observed, that the current expense of engines, in which power is obtained by the operation of fluids (such as steam or air) on pistons working in cylinders, depends so much on the friction of the parts, that large engines must necessarily be worked more cheaply than small ones. Referring to what appear the most effective of the locomotive engines in use, and which are pronounced from eight to ten horses' power, we find the working cylinder to be eight inches in diameter. The area of a circle eight inches in diameter, is, to the circumference, as two to one. The cylinders of large engines are, some of them, above 80 inches in diameter. The area of a circle 80 inches in diameter, is, to its circumference, as 20 to 1. In a cylinder of this size, there can, consequently, be only one-tenth of the (proportionate) friction there is in one of the former size. Now as the friction of the piston against the cylinder, when the packing happens to be screwed too tight, is sometimes sufficient, not merely to clog, but absolutely to stop the engine, it may be conceived, that engines in which the liability to this is only as 1 to 20, must be more economical than those in which this liability is as 1 to 2; and, consequently, that large engines are more economical than small ones, without adverting to the other circumstances which combine to render them so.

And if diminution of size operates thus disadvantageously, with reference to engines which, from being fixed, admit of all possible economy being exercised in working them, how much must this disadvantage be increased, when, in addition to being small, the engines are also locomotive. In consuming fuel, and applying its product, steam, to a stationary engine, the utmost possible economy the case admits of, may be exercised, let the engine be as small as it may. But in an engine, which, from being locomotive, renders lightness and efficiency considerations so imperative, that economy cannot one moment be regarded in comparison with them, neither the fuel, nor the steam, can be made use of in the most economical manner. It requires scarcely more than a bushel of coals per hour, to drive a 20-horse engine on Woolf's improved principle. But a bushel of coals will not, in locomotive engines, do the work of more than about four horses for an hour. Between them, and what are, comparatively small stationary engines, it appears, therefore, that there is a difference in the fuel consumed, of about five to one in favour of the fixed engine.

But in comparison with large engines, this difference increases in an important ratio. It is authenticated by the persons appointed to report the work performed by some 30 or 40 of the large engines in the Cornish mines, that in May, 1816, Woolf's engine in Wheal Abraham mine, raised 56,917,312 lbs. one foot high, with every bushel of coals it burnt; which is doing the work of 29.6 hours for an hour, with one bushel of coals.

And it is now said, that another engine of his, in the Consolidated mine, raises 87,360,000 lbs. one foot high with every bushel of coals burnt; which is equal to the work of 45.5 horses for an hour, with one bushel of coals. Now as this last statement is not, like the other, official, we will calculate only on the prior unquestionable one. And contrasting it with what is stated to be the effect of locomotive engines, we cannot but perceive, that should any means, by which large stationary engines could operate to move vehicles from one place to another ever be devised, a bushel of coals would go so much further than it can do in locomotive engines, that the mere expense of transmission might be scarcely more than one-tenth what it will be by locomotive engines.

Without regard to the loss of power, which must arise from the locomotive engine having to move its own weight of five or ten tons, it is evident, therefore, that the expense of rail-way conveyance can never be low enough, either to render impossible any improvement which should operate on them, as they are affecting canals; or to *insure the permanent productiveness* of the capital sunk in them.

The result of the investigation instituted to ascertain "how nearly rail-ways come up to the conditions which must be fulfilled, before the arts of intercourse can be considered to have attained the degree of perfection which shall render hopeless any improvement on them, and, consequently *insure* the permanent productiveness of the capital sunk in effecting them," therefore is, that they are decidedly, and importantly, defective in every particular.

HEADS OF PROSPECTUS

OF

The London,

BRIGHTON, AND SHOREHAM

PNEUMATIC CONVEYANCE COMPANY.

THE principle of transmission by atmospheric pressure being incontrovertible, and its practicability having been demonstrated to the conviction of every one who has examined it, advantage may be taken of an opportunity for putting it profitably into practice, and ascertaining at what rate it will be possible to go by it; what proportion of expense it will save; and whether the incalculable national benefits it appears to hold out can be realized, in the following manner:—

The official returns prove that above 50,000 tons of goods are annually conveyed by land carriage into Brighton from Shoreham, and that more than 20,000 tons are landed on Brighton beach; but as there are many other goods brought into Brighton from Newhaven and Lewes, besides those officially certified, the amount of tonnage is at the least 75,000 tons, while in the opinion of the collectors at both places the total quantity exceeds 100,000 tons.

Owing to the dangers attendant on the landing of goods upon Brighton beach,[1] and to the higher price paid for such goods delivered there, it is obvious, that were a method of conveyance in operation, between that town and Shoreham, capable of reducing the present charge for carriage low enough, the whole of these goods would be delivered in the harbour at Shoreham. The principle of transmission by atmospheric pressure will effect, not only a saving in carriage equal to fifty per cent., but vessels need no longer be exposed to the danger of shipwreck on the beach at Brighton.

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[1] On an average of five years six vessels have been annually wrecked on Brighton Beach; the danger of which renders coals landed there several shillings per chaldron dearer than if delivered in the Harbour at Shoreham. Since this letter was sent to press, two ships have been knocked to pieces.

The charge for carrying goods from Shoreham Harbour to Brighton varies from five shillings to eight and fourpence per ton; and those who have the largest quantity of the heaviest goods (pig-iron) consider six shillings per ton the average cost. The expence of power for moving a ton of goods from Shoreham Harbour to Brighton by atmospheric pressure will not be two-pence, and as ten-pence more will cover all the expence of transit, the mere cost of conveyance will be only one sixth of what is now paid: one shilling per ton, that is.

The principle can be executed and rendered effective between Brighton and Shoreham for £75,000. A toll of 1s. per ton, on 75,000 tons, will pay five per cent. on the total outlay; and as reducing the charge for carriage 50 per cent. will be a sufficient benefit to the public, another shilling may be imposed by way of toll, and the return raised to a clear profit of ten per cent.

But it is not from the conveyance of goods alone that profit would be derived. Were a principle so extraordinary as is here adverted to, in operation between Brighton and Shoreham, curiosity would bring persons from all parts of the kingdom to see it; who would doubtless willingly pay a few (say five) shillings each, to be carried from Brighton to Shoreham and back again by it, and witness the effect of the machinery and pneumatic apparatus at both ends. The number of persons who now visit Brighton, exceeds 100,000 annually; hence it may be expected that the whole sum expended for putting the principle in practice between Brighton and Shoreham would be returned from this source alone, within *a few years;* in which case each subscriber would receive back his original investment, while the profit accruing from the conveyance of goods (without passengers) would yield an annual bonus of ten per cent. from the completion of the work, till it was worn out: a period of perhaps half a century.

The principle *may* be rendered effective between Brighton and London for £500,000, so as to bring these two places nearer together (in point of time) by much more than half than they are now. The number of passengers from the metropolis to Brighton, has been stated to exceed even now, 100,000 annually; and allowing for those who return, including visitors from other parts of the coast and the continent, the passage money actually paid may be calculated on 200,000, independent of goods; which are estimated to amount to 30,000 tons a year by land carriage only. The present fare (averaging inside and outside passengers) is 15s. each. Now, if persons can be conveyed in half, or one-fourth the time, without the possibility of being *overturned*, and in perfect safety from other accidents incidental to coach conveyance,[1] with greater certainty and convenience, besides having no road expences to pay, it will not be necessary to reduce the present charge for conveyance. Thus, 200,000 persons, at 15s. each, would be equal to an aggregate return of £150,000 per annum.

The expence of power to convey 300 people and 50 tons of goods from London to Brighton and back every day in the year, in one-fourth the time it now takes to travel that distance, will not exceed £20 per day, or £7300 per annum. Allowing £25,000 for expences, this will leave a profit of 25 per cent. on the cost of putting the principle in operation from Brighton to London, considering the existing traffic only between those places. But it must be evident to every one, that were means adopted by which the space separating the metropolis from the coast, could be passed over as rapidly as this principle will admit, and the latter eventually brought within perhaps, *less than an hour of the other*, the present traffic would be increased in a proportion no one can estimate; and the value of each £100 share enhanced in a corresponding proportion.

Therefore, to secure to those who advance the amount necessary for the first trial between Brighton and Shoreham every possible advantage as original subscribers, it may be proposed to establish the Company, not with reference to Brighton and Shoreham only, but to reserve in the Act of Parliament for that object, a right of putting the principle in practice between Brighton and London also, provided the

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[1] "Should it be wished, day-light might also be admitted into the cylinder through its whole course. But as it must necessarily be lighted with gas during half the twenty-four hours;—as providing for the admission of day-light would be incurring considerable expense, for a purpose, which the provisions that must unavoidably be made for gas-light, would equally well answer;—and as the little time a journey of one hundred miles *might* take up, would render it a matter of indifference, whether we were, during that period, cheered by natural, or artificial light, it is expected, that arrangements to admit the light of day will be seen unnecessary."—*Insular Defence.*

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